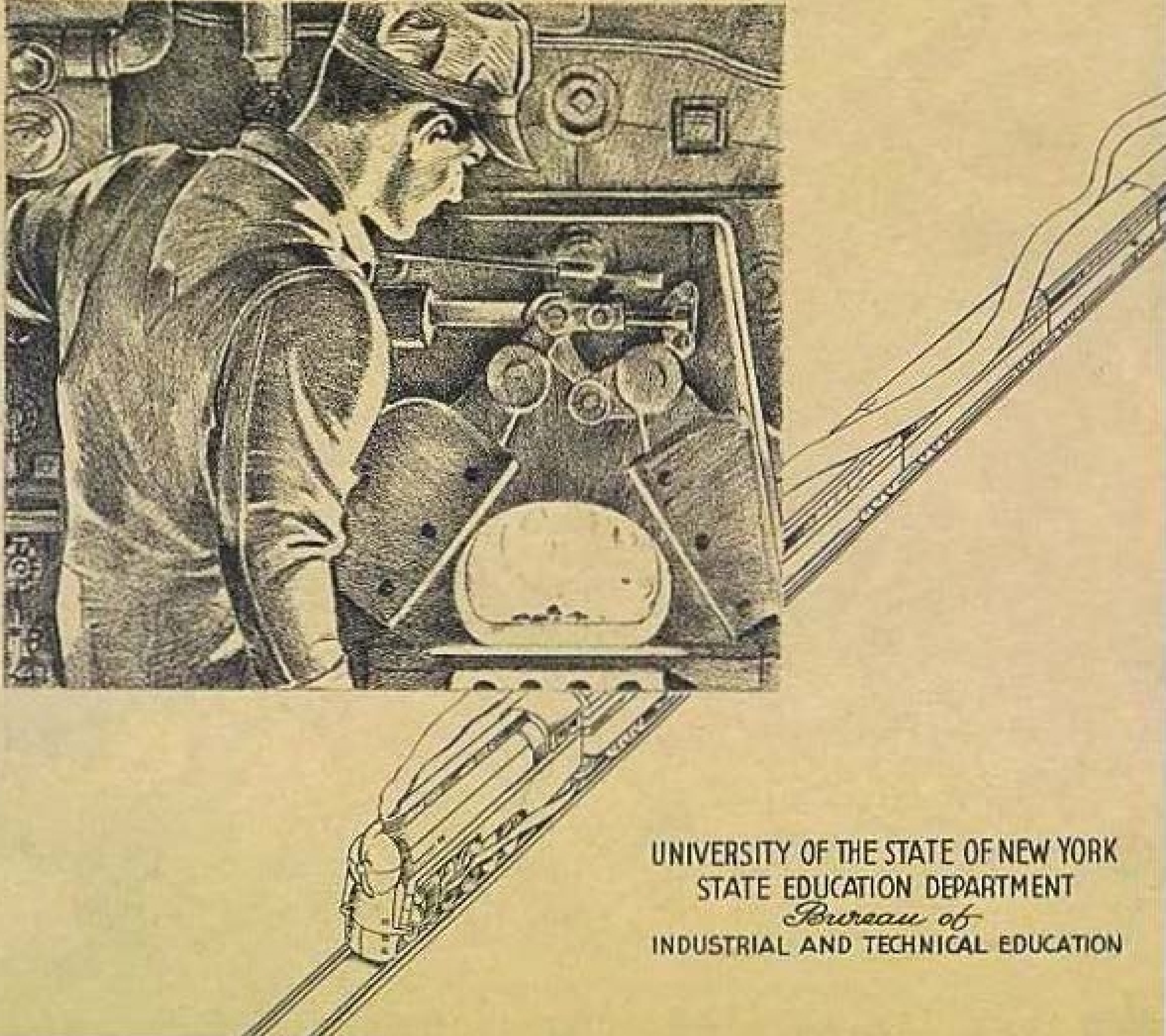
SUGGESTED UNIT COURSE

in Locomotive

FIRING



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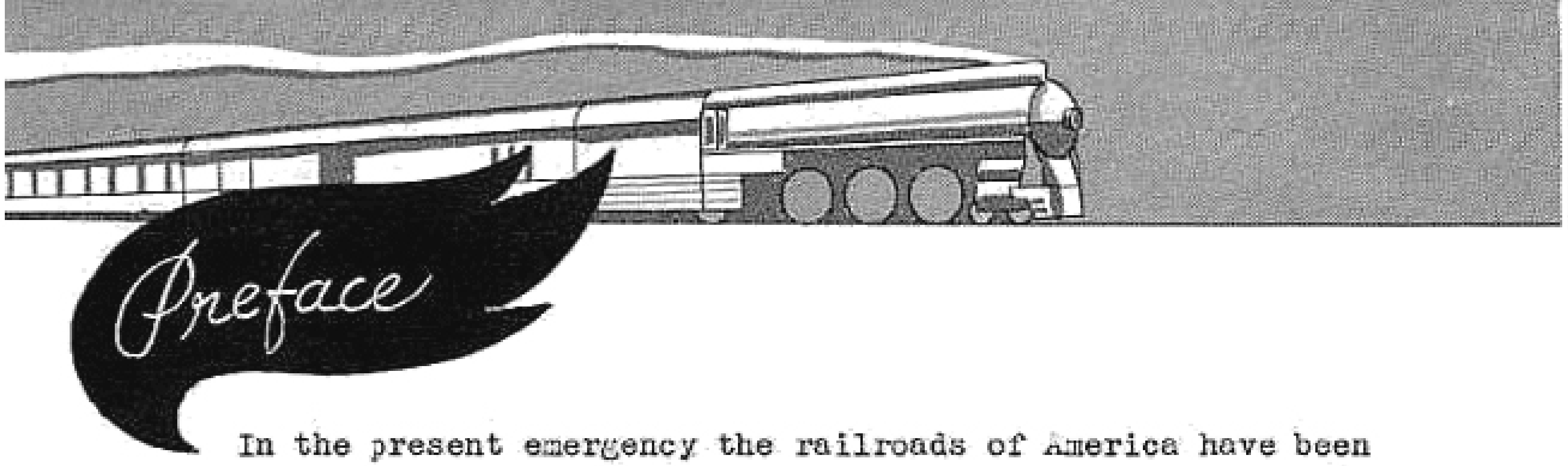

Preface

In the present emergency the railroads of America have been called upon to exceed all past accomplishments under unprecedented difficulties. The increase in the number of locomotives in service, the capacity loads being hauled, and the high speeds at which trains are now run have multiplied the problems of the men who run the railroads.

The material in this manual has been developed to assist the railroad fireman to perform the varied jobs involved in firing a modern locomotive more efficiently. The material should be of value in connection with the training of new firemen and also in the solution of many problems being encountered by experienced firemen.

We wish to express our appreciation to the Board of Education of Buffalo, New York, for providing the Curriculum Construction Laboratory facilities in Seneca Vocational High School where the manuscript was prepared; to the New York Central Railroad for the assistance of members of the staff of the Fuel and Locomotive Performance, and Maintenance Divisions; and to the members of the laboratory staff who developed and edited the material.

Albany, New York

July 1944

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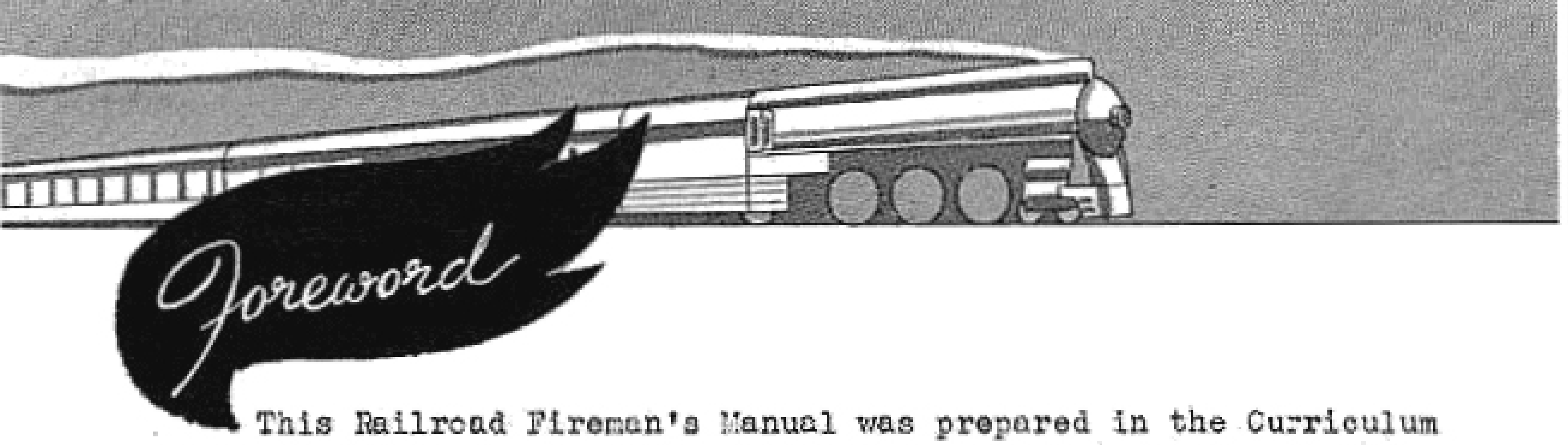

Foreword

This Railroad Fireman's Manual was prepared in the Curriculum Construction Laboratory in Seneca Vocational High School, Buffalo, New York, as a part of the New York State program of vocational training for workers in war industries under the direction of Oakley Furney, Assistant Commissioner for Vocational Education.

The information and working procedures described are based on operating experiences of the New York Central System; on the booklet "Instructions for the Preparation and Maintenance of Locomotive Fires", prepared by the New York Central System; and on instruction manuals prepared by the manufacturers of locomotive equipment.

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Special acknowledgment is made to Robert T. Bapst, Superintendent of Schools, Francis H. Wing, Associate Superintendent of Vocational Education, Richard A. Reagan, Principal, Seneca Vocational High

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Appreciation is expressed to the following members of the supervisory staff of the New York Central System for their assistance in the preparation and review of the material in this manual:

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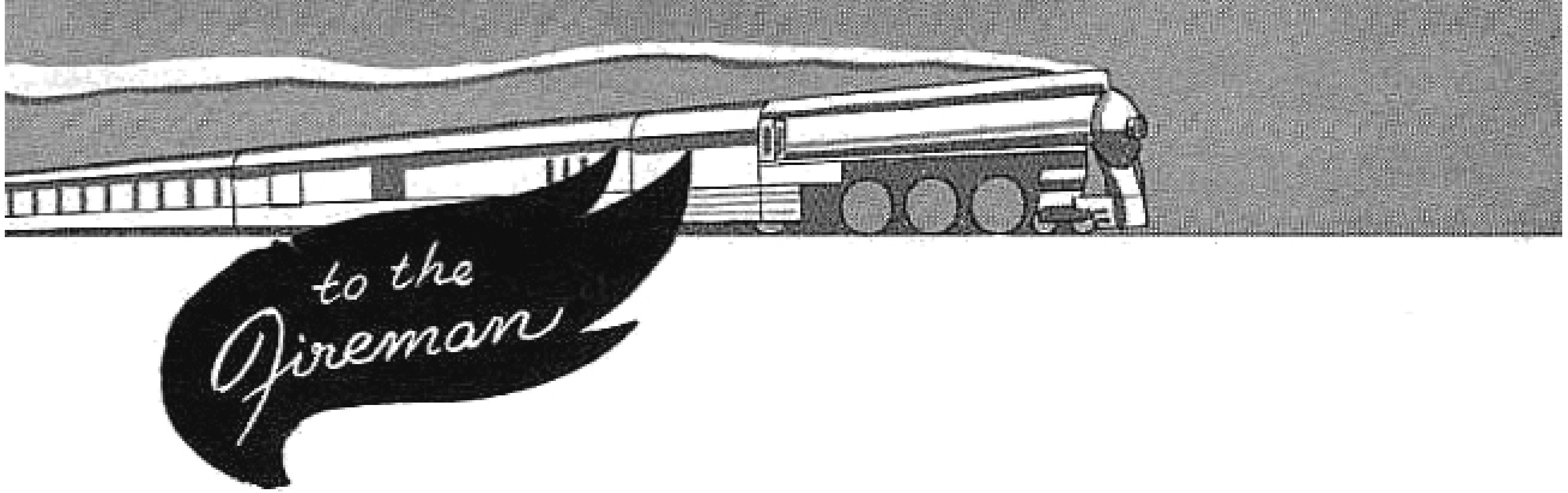

to the Fireman

The fireman of the modern locomotive must have a thorough knowledge of firing methods that must be pursued in order to evaporate as much water into steam as possible with every pound of coal burned.

This manual contains information selected to give the new fireman a knowledge of locomotive-firing methods that have proved most satisfactory. This information may help the experienced fireman to improve the results he is now getting.

The contents of this manual include information units and procedure units. The units included in the Firing Information (Why-to-Do) Series, describe the equipment that the fireman uses and they also supply other information that will enable him to do his work more intelligently. The units included in the Firing Procedure (How-to-Do) Series, give step-by-step procedures for doing the jobs that a fireman must perform to maintain the proper steam pressure in a locomotive boiler. The Information Units alternate with the Procedure Units. In the table of contents the Information Units are listed in the left-hand column and the Procedure Units in the right-hand column. The units have been arranged into sections so that those dealing with the same topic are grouped together.

A detailed index is provided in the back of the manual.

There are different kinds of equipment used on locomotives and there are many variations in the application of it to individual locomotives. An effort has been made to make the information in this manual broad enough so that it can be applied to all locomotives in general use. References are given after each unit in the Information Series. These can be used for more detailed information.

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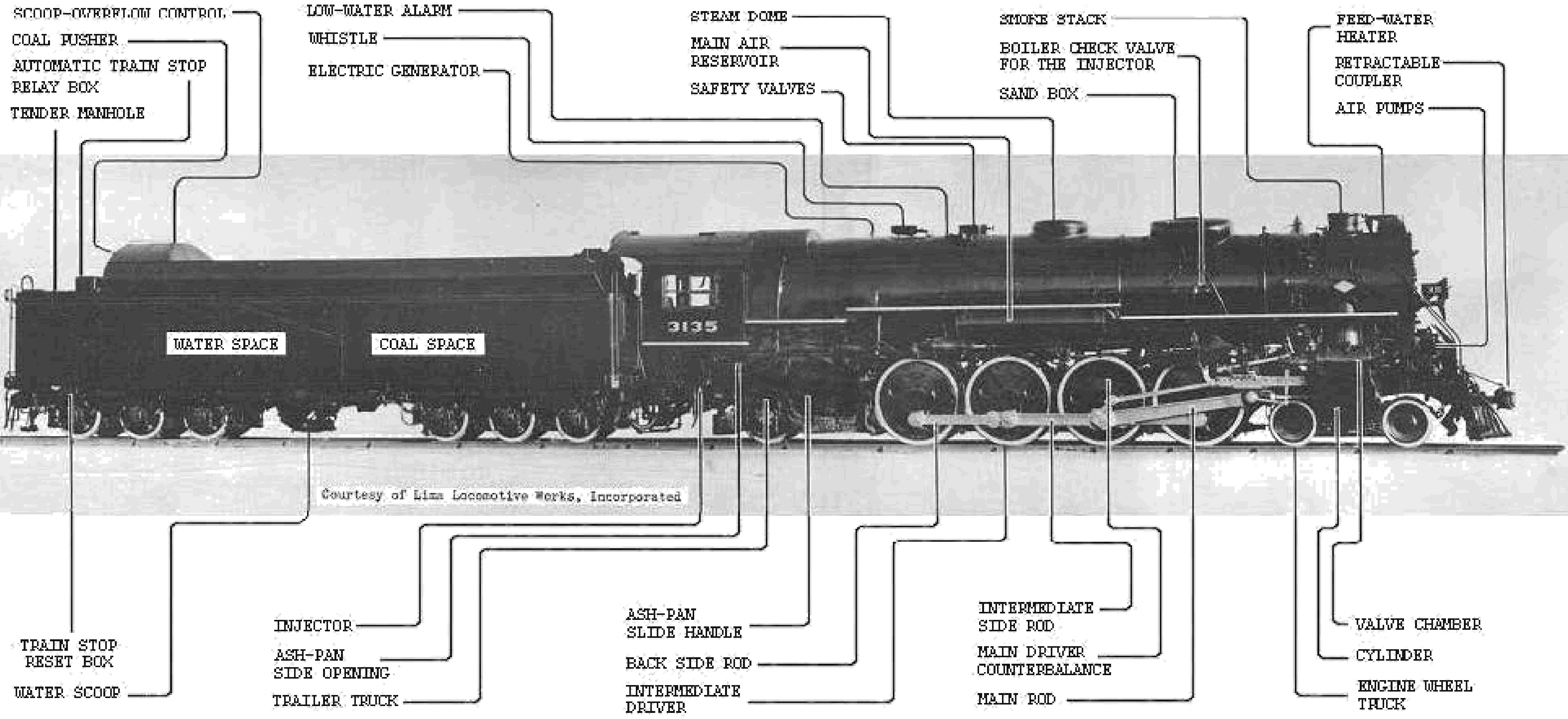
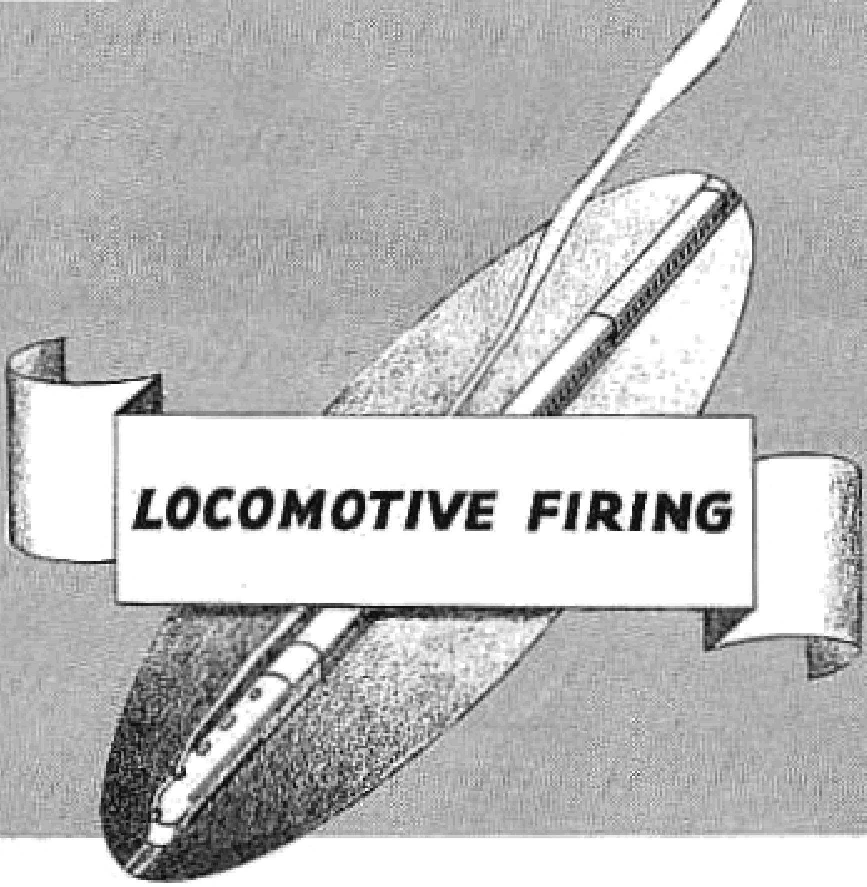
*
I = Information
P = Procedure

MODERN STEAM LOCOMOTIVE



Courtesy of Lima Locomotive Works, Incorporated



INTRODUCTION TO LOCOMOTIVE FIRING

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CREW COOPERATION

OBJECTIVES

1. To emphasize the importance of crew cooperation.
2. To point out ways in which cooperation can be practiced.
3. To list the fireman's duties.
4. To show the value of reports.

INTRODUCTORY INFORMATION

In no other situation is close cooperation more important between two persons than between the fireman and engineman in the cab of a modern locomotive. Upon the decisions and performance of these two men depend the safety of the passengers and the crew, and the care of valuable freight and railroad equipment.

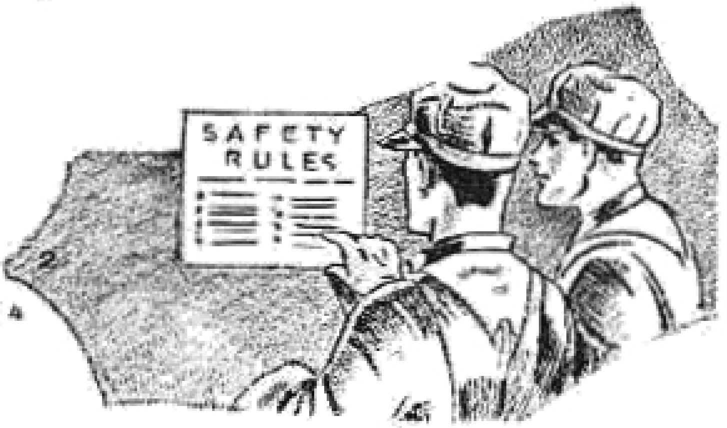
The engineman is responsible for the locomotive and the performance on the road. The fireman is responsible to the engineman. A recognition of this relationship and a willingness to cooperate will make for teamwork and will get the best possible results under all conditions.

One steam failure resulting from poor firing or lack of crew cooperation is far reaching, and may tie up an entire section of the railroad system. The average person does not realize how much experience, information, and teamwork are necessary to bring about an "on-time performance."

There are many ways in which the individuals responsible for the operation of a locomotive can help each other. Good cooperation will enable each individual to do his job better and will get the best performance and efficiency from each locomotive. The information in this manual points out some of the ways in which the crew of a locomotive can cooperate.

WHERE TO GET INFORMATION

The material contained in this manual covers only that information which a locomotive fireman must have to fire the locomotive.



It deals only with the fire and the boiler.

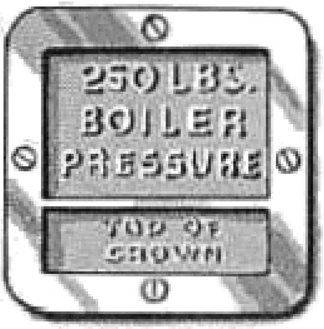
Safety-first is stressed in this book because safety is most important to railroad men.

Detailed information about the equipment used on locomotives can be found in catalogs and instruction manuals supplied by the manufacturers of locomotive equipment. The references listed at the end of the informational units in this manual have much additional information.

The fireman should get all the information he can about his job while he is getting experience so that he can use good judgment at all times and will know what to do at the right time. There are several sources of information that will be of great assistance to him. A few suggestions are offered here:

1. Ask other railroaders for correct information pertaining to the duties of locomotive firemen.
2. Go to the engineman. He has had years of firing experience and knows the peculiarities of the locomotive being fired.
3. Ask the traveling fireman or supervisors for assistance with the regular work and with special problems.
4. Take every opportunity to inspect breakdowns and disabled engines. See what parts gave way and try to determine what caused each failure to occur.
5. Observe how other men care for failures, as this knowledge may be of great value in an emergency.
6. Read the instruction manuals for firemen frequently until you are familiar with the contents.
7. Study the information and procedure in this manual. Reference books are listed after each information unit. These give additional information on many details and variations of the subjects covered.
8. Use the Technical Department of the public libraries for additional information on locomotive firing.

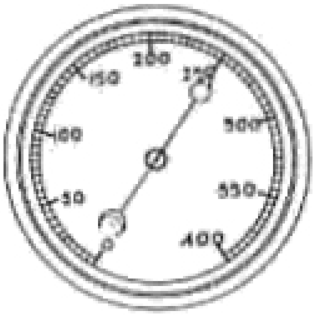
COOPERATION IN FIRING THE LOCOMOTIVE



BADGE PLATE

HOSTLER AND ENGINE CREW

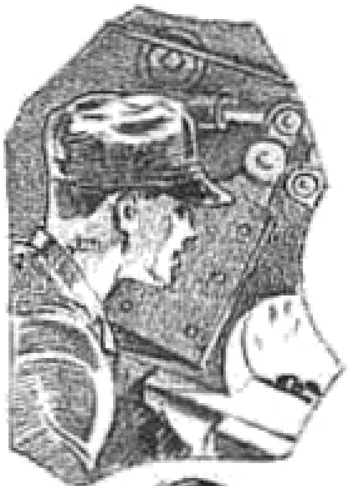
The fire builder, the engine watchman, and the hostler should make certain that the locomotive is turned over to the engine crew with a good, well-coked fire, not over two gages of water, and steam pressure within fifty pounds of the maximum boiler capacity indicated on the badge plate.



FIREMAN'S DUTIES ON ARRIVAL AT ENGINEHOUSE

1. Report to engine dispatcher or foreman.
2. Consult bulletin board.
3. Compare watch with standard clock.
4. Register on prescribed form.

FIREMAN'S DUTIES AFTER ASSIGNMENT TO LOCOMOTIVE



1. Note amount of water in boiler. (Refer to Unit P-5.)
2. Note steam pressure.
3. Examine the firebox for leaking crown sheet, staybolts, and flues.
4. Check for plugged or honeycombed flues.
5. Check condition of brick arch.
6. Put fire in condition. (Refer to Units P-1, P-2, P-6, and I-13.)
7. Blow out water glass and gage cocks. (Refer to Unit P-5.)
8. Compare gage cocks with water glasses.
9. Check coal supply.—See that coal is properly trimmed so that it will not fall off to cause waste of fuel and danger of injury to persons along the right of way.
10. See that water, sand, flagging equipment, and all necessary tools are provided. Follow local instructions. (Refer to page 14.)
11. Close and secure all ash-pan openings provided with closures. Follow local instructions if these are to be left open.

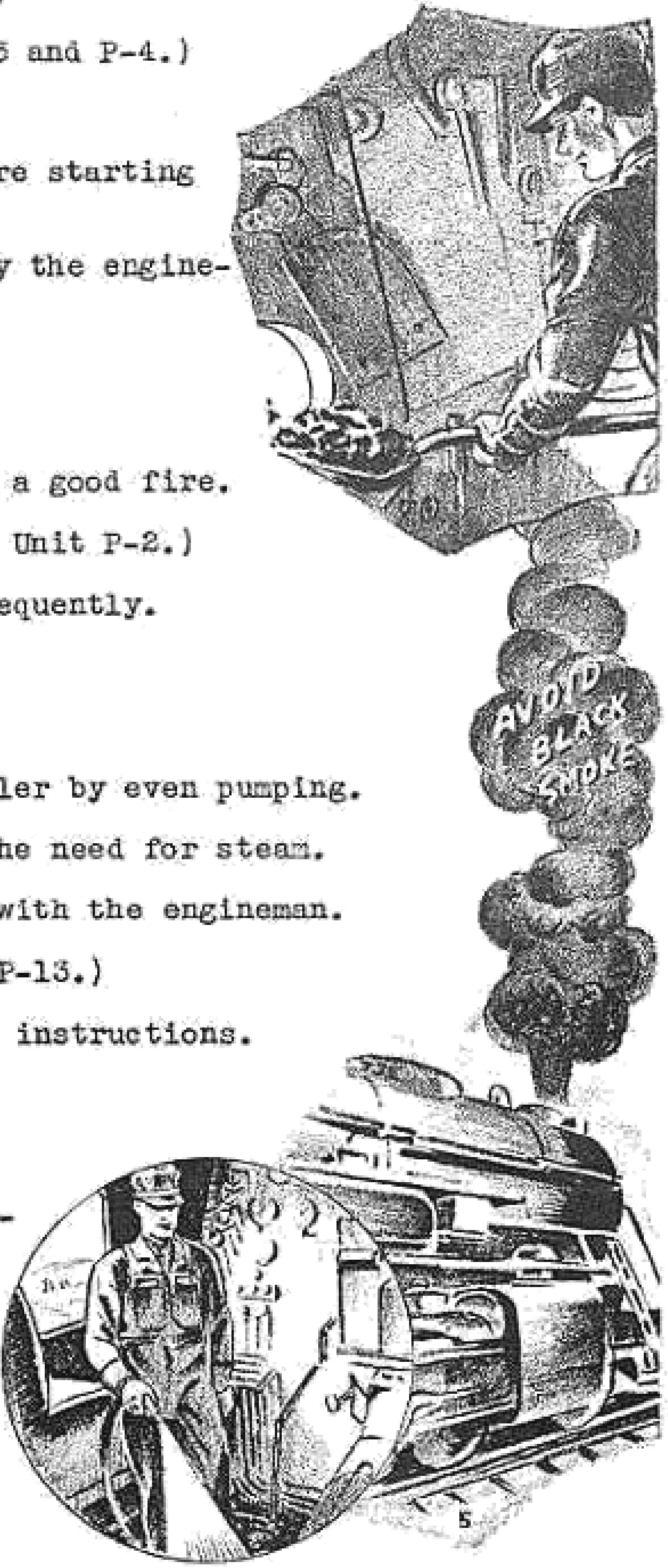
12. Test injectors and water pumps to see that they work properly. (Refer to Unit P-5.)
13. Inspect stoker. (Refer to Units P-3 and P-4.)
14. Lubricate stoker and coal pusher.
15. Build up the fire with a SCOOP before starting out. Follow local instructions.
16. Perform any other duties assigned by the engineman.

FIREMAN'S DUTIES ON THE TRIP

1. Observe all safety precautions.
2. Start stoker operation and maintain a good fire.
3. Inspect fire frequently. (Refer to Unit P-2.)
4. Check size and condition of coal frequently.
5. Watch, and call, all signals.
6. Maintain proper steam pressure.
7. Maintain correct water level in boiler by even pumping.
8. Plan ahead, and fire according to the need for steam.
9. Operate water scoop in cooperation with the engineman.
10. Avoid black smoke. (Refer to Unit P-13.)
11. Blow down boiler according to local instructions.
12. Keep deck clean.

FIREMAN'S DUTIES AT END OF TRIP

1. Have two gages of water in the boiler or follow local instructions.
2. Ease off on firing before arrival at terminal so that fuel will not be wasted, but still maintain sufficient fire to keep the steam pressure up until the hostler takes charge. If possible, get fire in shape by hand firing.



3. Before arriving at the terminal at the end of the trip, shut off the stoker by putting the stoker-operating lever in neutral position and by closing the stoker-engine throttle valve and jet valves. The leakage ports will furnish sufficient steam to protect the steam jets and the distributing plate.

4. Report to the engineman any defects in the boiler, firebox, stoker, water-supply system, or any other defects that affect the performance of the locomotive or may cause a mechanical failure.

WHERE COOPERATION COUNTS

The engineman should avoid slipping, if possible, as this has a tendency to tear holes in the fire.

The fireman should notify the engineman of any bad condition in the firebox so that he can work the engine accordingly until the trouble can be corrected.

The fireman should anticipate the need for more or less steam and control his fire accordingly. When the locomotive is approaching a long pull, a long down grade, stops, etc., the amount of coal must be varied to meet the condition.

REPORTS

The fireman should cooperate with the engineman by giving him a report of any defects that have been discovered so that they can be included in his report. A complete, intelligent report will assist the repair department in maintaining the locomotive in good condition.

The fireman should report especially on the crown sheet, flues, grates, stoker, brick arch, fire-door opener, ash pan, and superheater.

SELECTED REFERENCES

Instructions for the Preparation and Maintenance of Locomotive Fires	New York Central System
Traveling Engineers' Examination Book	Railway Fuel and Traveling Engineers' Association
Fuel Economy on Locomotives	American Railway Association
Examinations for Firemen & Hostlers	New York Central System

HOW TO PREPARE THE FIRE

OBJECTIVES

1. To call attention to the duties of the fireman and hostler in caring for a fire.

2. To explain the reason for using the blower and smoke consumer when adding coal to the fire.

3. To explain how to prepare the fire before starting out.

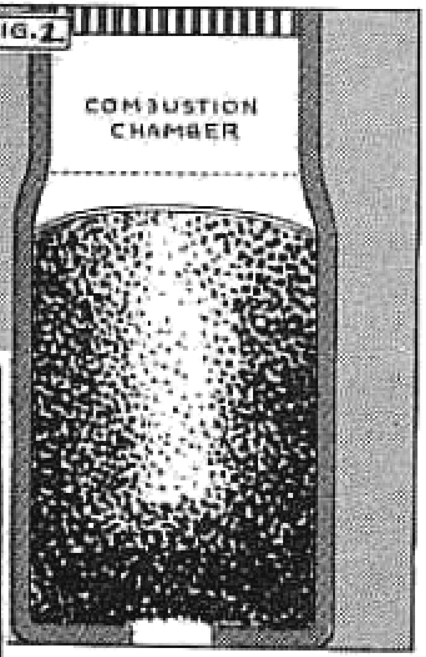
4. To emphasize the importance of putting the fire in the best possible condition by hand firing before starting on a run.

INTRODUCTORY INFORMATION

The importance of starting out with a good fire cannot be overemphasized. Serious difficulties may be encountered on the road if the fire is not properly prepared and cared for before starting out. The fire should be banked according to local instructions, should be in good condition, and the steam should be within fifty pounds of maximum pressure when the locomotive is turned over to the engine crew.

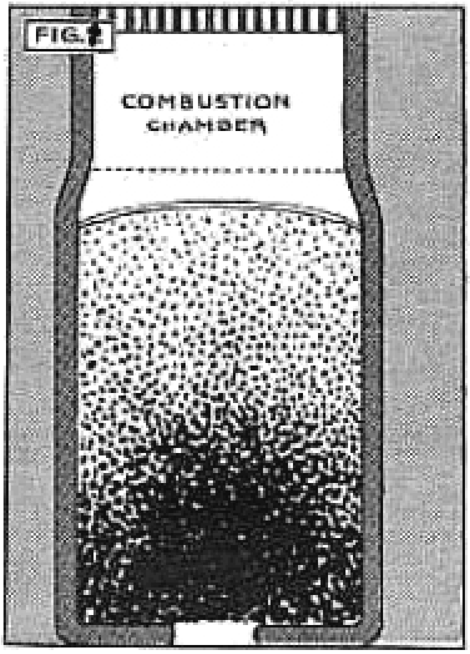
One of two types of banks is used in preparing a fire for the ready track: (1) the center bank (Fig. 1), or (2) the horseshoe bank (Fig. 2). If the center-bank method is used, the bank must be leveled off about five minutes before train departure, but the horseshoe bank should not be disturbed prior to leaving. The banks referred to in this unit must not be confused with banks which form as a result of poor firing while the locomotive is under way.

FIG. 2



Just enough coal should be added by hand around the center bank to maintain steam pressure. Fill in the center of the horseshoe bank by hand. The blower and the smoke consumer should be used until the smoke clears up.

FIG. 1



The fireman should check before starting on a run to see that the standard tools and equipment are on the locomo-

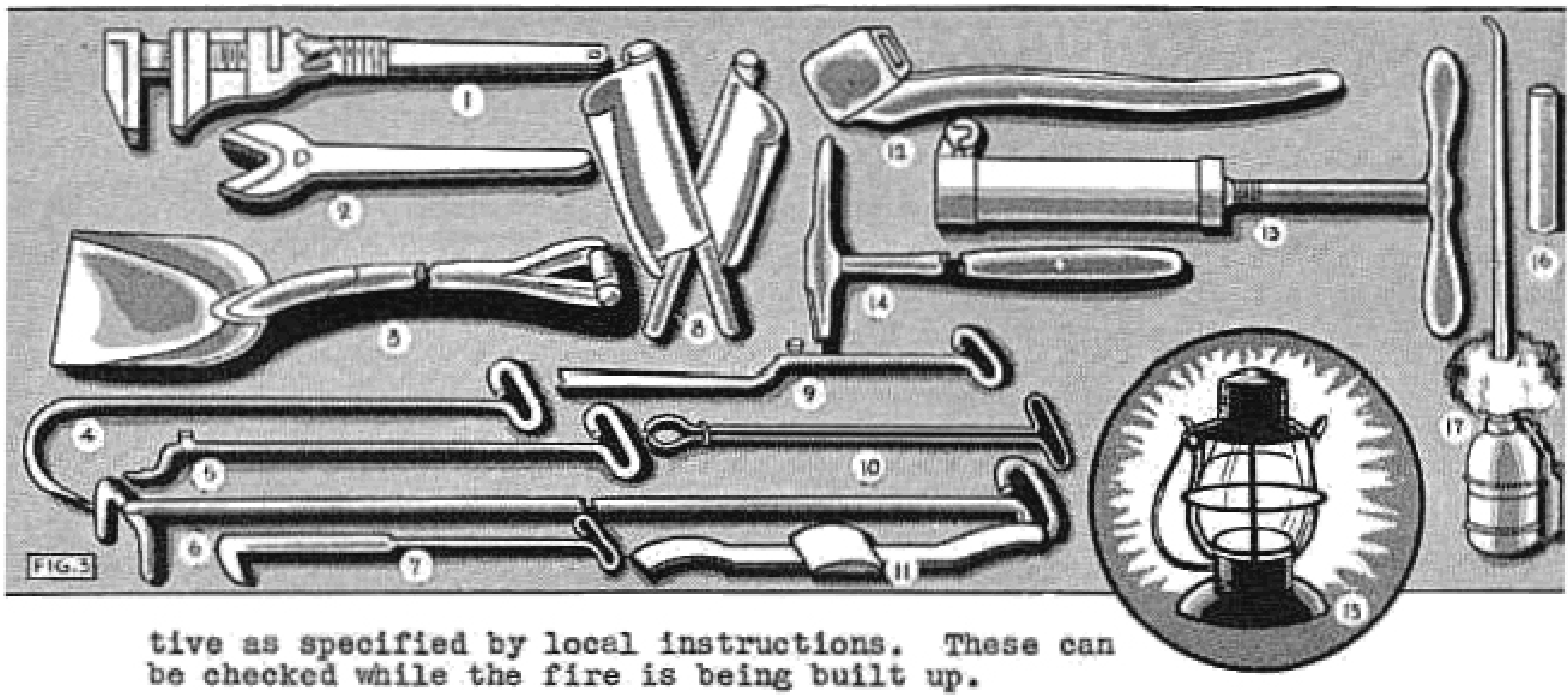


FIG.3

tive as specified by local instructions. These can be checked while the fire is being built up.

The equipment listed below and illustrated in (Fig. 3) should be on the locomotive to enable the crew to carry out their regular duties and to take care of emergencies that may arise on the trip.

EQUIPMENT REQUIRED

The equipment provided should comply with local instructions.

1. Monkey Wrench
2. Alligator Wrench
3. Scoop Shovel
4. Jet Hook
5. Slide Hook
6. Fire Rakes
7. Packing Hook
8. Flags (Red and White)
9. Packing Spud
10. Wire Torch
11. Torpedoes
12. Shaker Bar
13. Grease Gun
14. Coal Pick
15. Lanterns (Red and White)
16. Fusees
17. Oil Can and Waste
18. Drinking Water Container (not shown)

PROCEDURE

HOW TO CARE FOR THE FIRE WHILE THE LOCOMOTIVE IS ON THE READY TRACK

A. Inspect the fire by the following procedure to ascertain that it is properly banked.

NOTE: Follow local instructions for preparing fire.

1. Open the fire door by depressing the foot pedal (Fig. 4.)

   NOTE: There is a valve in the air line to the fire-door operating cylinder to shut off the air when the door is being operated by hand. Open this valve if it is closed.

2. Apply the smoke consumer by turning the smoke-consumer valve (Fig. 5) to clear up the gases in the firebox. Refer to Unit I-13 for a description of the smoke consumer.

3. Inspect the banked fire. The condition of the banked fire should be judged according to the length of time the locomotive will be on the ready track. The purpose of this bank is to provide a well-coked foundation upon which the fireman can build up the fire before train departure.

   NOTE: The bank should not be disturbed while the locomotive is on the ready track. Disturbing the bank will cause the fire to burn out.

4. Watch the boiler pressure and prevent the engine from popping while maintaining the fire on the ready track.

B. Add coal to the banked fire by the following procedures:

1. Turn on the blower to provide the necessary draft to maintain the fire and to eliminate smoke while coal is being added with the scoop. Refer to Unit I-13 for a description of the blower.

2. Use the scoop to add sufficient coal to the bank in the firebox to maintain the fire and to maintain steam pressure. The amount of coal required will depend on how long the locomotive will remain on the ready track.

3. Build up the fire so that it will be in good condition, and have within fifty pounds of maximum steam pressure when the locomotive is taken over by the crew. The recommended boiler pressure for the locomotive is shown on the "badge plate" located on the back boiler head (Fig. 6).

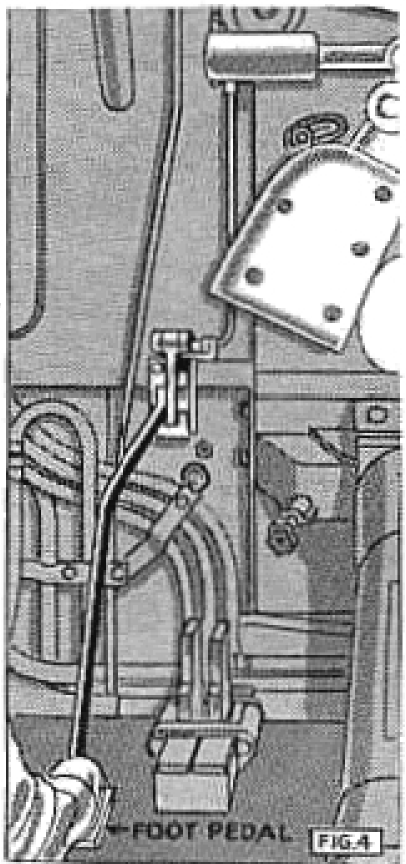


FIG.4

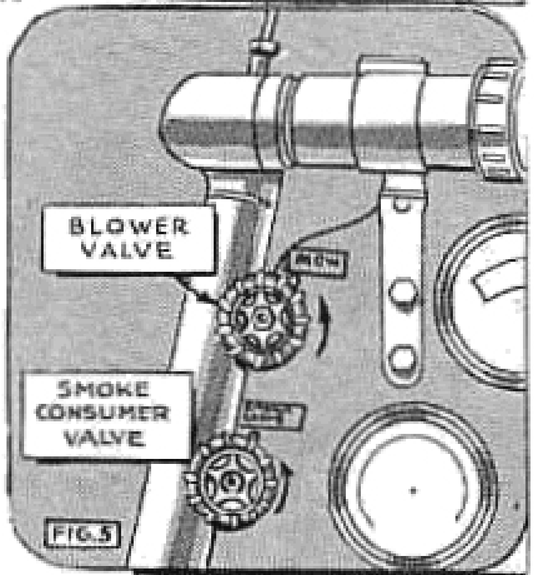


FIG.5

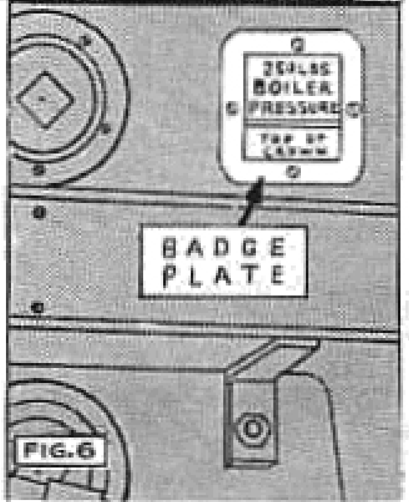


FIG.6

FIREMAN'S DUTY IN PREPARING FIRE

1. Apply the smoke consumer (Fig. 5) enough to clear up the gases in the firebox and to eliminate smoke while preparing the fire. (See Unit I-13 for a description of the smoke consumer and the blower.)

2. Turn on the blower (Fig. 5) to provide the necessary draft to eliminate smoke when preparing the fire.

3. Level off the center bank with a fire rake about five minutes before departing time. Do not disturb the horseshoe bank prior to leaving. Add enough coal to build up the boiler pressure to approximately maximum pressure. Before departing see that the fire is well burned through and 6" to 8" deep with the back ends slightly heavier than the rest of the fire.

   NOTE: Although the use of the fire rake tends to start the formation of clinkers, it is permissible to use it at this time because the firebox temperature is low and there is little possibility of clinkers starting to form.

4. Check the coal and water in the tender. Check the water level in the boiler according to local instructions. The water level should not exceed two gages at any time (Fig. 7). Refer to Unit P-5, How to Pump the Boiler.

5. Shut off the smoke consumer and the blower after the fire is prepared and the smoke is cleared up. The stoker should not be used until the locomotive is departing with train. However, the stoker should be tested at this time to make certain that it is in good operating condition before leaving the terminal.

6. Start stoker operation after leaving the terminal. Adjust the stoker speed to maintain the proper boiler pressure and adjust the stoker jets to distribute the coal evenly over the fire. (Refer to Unit P-4 for instructions for adjusting the stoker jets.)

   NOTE: While the locomotive is on the road, banks in the firebox should be avoided. A clean, even fire of 10" or less in depth should be maintained at all times if maximum locomotive performance is to be obtained. (See Unit P-6 for instructions for firing different kinds of coal on the road.)

7. Inspect the fire frequently. (Refer to Unit P-2.)

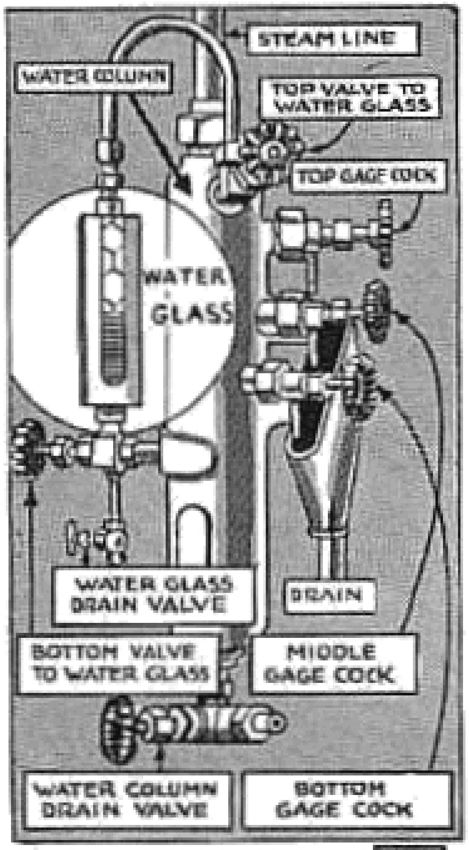


FIG. 7

THE LOCOMOTIVE BOILER

OBJECTIVES

1. To describe the general construction of the locomotive boiler.
2. To describe the three main sections of the boiler.
3. To point out how bad firing practices can damage the firebox and boiler flues.
4. To emphasize the danger of a burned crown sheet.

INTRODUCTORY INFORMATION

This unit describes features of the boiler that make it possible to get good efficiency from a locomotive by good firing, and lays particular stress on things to avoid in order not to damage the boiler.

The fireman has three important responsibilities in respect to firing the boiler:

1. To maintain the proper water level in the boiler at all times.
2. To maintain proper steam pressure by maintaining a good fire.
3. To prevent damage to the boiler by avoiding quick contraction and expansion of the boiler.

The locomotive fireman does not need to know all of the engineering technicalities and details of construction that go into the building of a locomotive boiler, but a knowledge of some features of the flues, firebox, and smokebox is necessary if he is to get the full efficiency from the locomotive with a minimum of fuel. Poor judgment can cause damage to the boiler and firebox if the fireman does not realize the importance of avoiding rapid changes of temperature with the resulting expansion and contraction of the metal parts of the boiler. It is particularly important to avoid doing anything or allowing any conditions to exist that will cause sudden changes in temperature in the boiler or cause uneven temperature in parts of the boiler.

To give best results, a boiler must be free from leaks, mud, and scale. No flues should be stopped up.

The ability of the locomotive to do work depends on the steam pressure in the boiler.

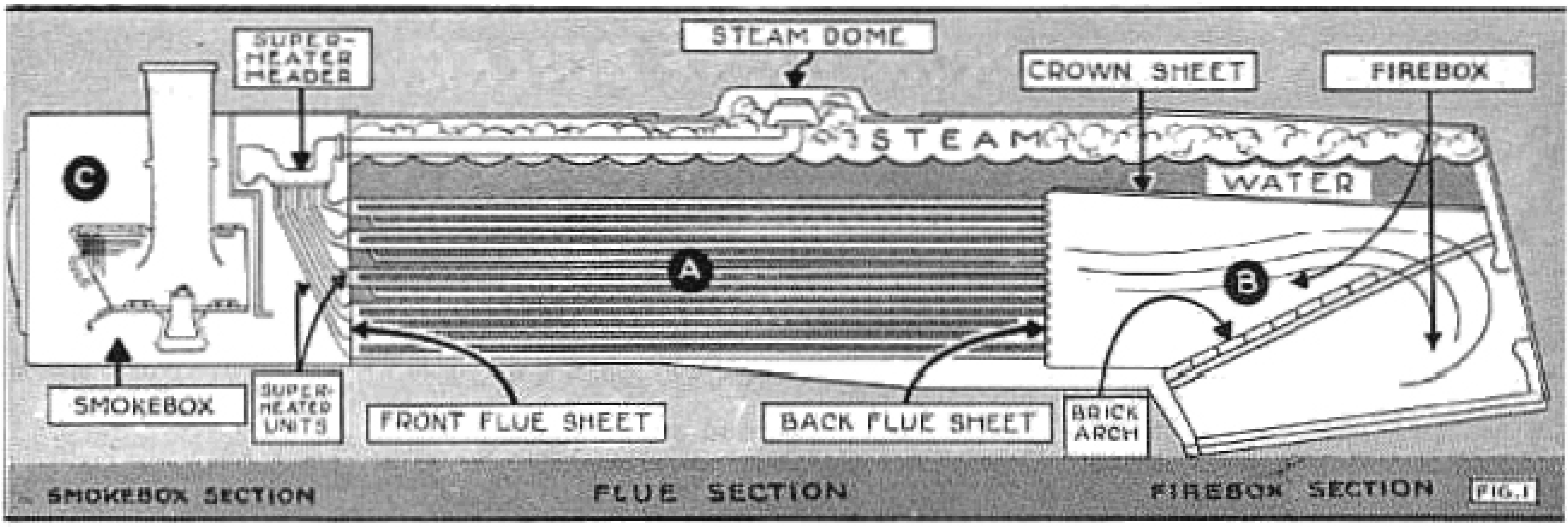


FIG. 1

In an open container, water boils at a temperature of 212° F. In a closed container, such as a locomotive boiler, the steam cannot pass off and therefore builds up pressure in the boiler. When more heat is applied, the steam pressure is increased.

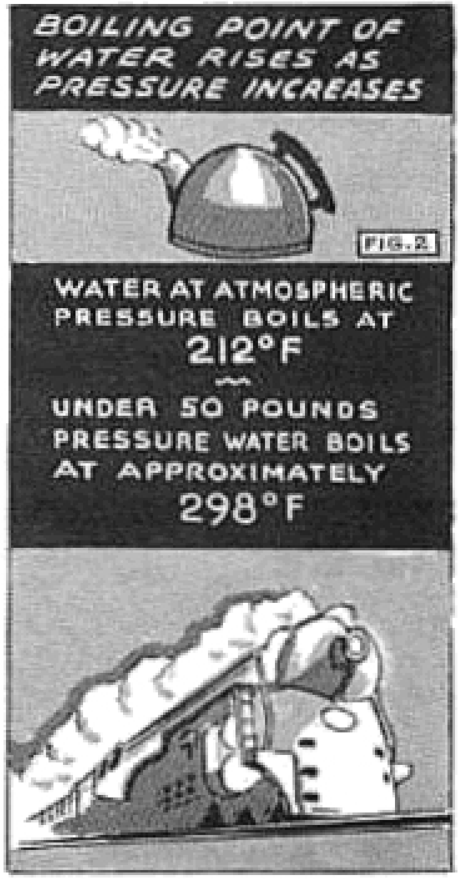

BOILING POINT OF WATER RISES AS PRESSURE INCREASES
WATER AT ATMOSPHERIC PRESSURE BOILS AT 212°F
UNDER 50 POUNDS PRESSURE WATER BOILS AT APPROXIMATELY 298°F

FIG. 2

The temperature at which water will boil rises as the steam pressure in a boiler increases, and consequently more heat must be applied to keep the water boiling (Fig. 2). The water temperature must be raised to about 298° F. before the boiling point is reached when the boiler pressure is fifty pounds. The temperature must be raised to 380° F. to boil water under one hundred and eighty pounds pressure. These facts make it clear why a good fire and good boiler conditions are important in order to get sufficient heat to keep the water boiling under the working pressure of the locomotive when it is working and steam is being used.

THE LOCOMOTIVE BOILER

The locomotive boiler (Fig. 1) consists of three main units: the cylindrical section (Fig. 1-A) which contains the flues and superheater units; the enlarged back section (Fig. 1-B) which contains the firebox; and the front section (Fig. 1-C), called the smokebox or front end, which contains the draft appliances.

THE FIREBOX

The firebox (Fig. 3) is built into the rear section of the boiler and, except for the grates, is entirely surrounded by water.

The heating surfaces of the firebox are those parts that are directly exposed to the fire or heat from the fire and are surrounded by water. These are principally the four sides and the top of the firebox and the flues. The sides of the firebox and the top, called the crown sheet, transmit intense heat to the water and therefore the most active generation of steam takes places around these heating surfaces.

The CROWN SHEET (Fig. 3) is subjected to the most intense heat in the firebox. It is also the part of the firebox that will be uncovered first if the water in the boiler gets too low. If the crown sheet is uncovered for a very short time, it may be burned. If it is badly burned, the metal softens and may bulge downward and pull the crown-support bolts through the metal. The result would be a ruptured crown sheet and an explosion. A burned crown sheet can be detected by its color and by leakage around the crown-sheet bolts.

A fireman should know that the water glasses and gage cocks are in good working condition, and he should check them frequently so that he will know how much water is in the boiler at all times. He should be on constant guard against low water in the boiler while he is on a locomotive, and should always examine the firebox before and after a run for indications of burning or leakage.

A BRICK ARCH supported by arch tubes (Fig. 3) is built into the firebox. The arch is necessary because a large quantity of gases is given off during the process of combustion; the arch helps to burn these gases more completely by forcing them back over the bed of the fire (Fig. 3). This action thoroughly mixes the air and gases before they enter the flues and this promotes good combustion which saves fuel and prevents black smoke.

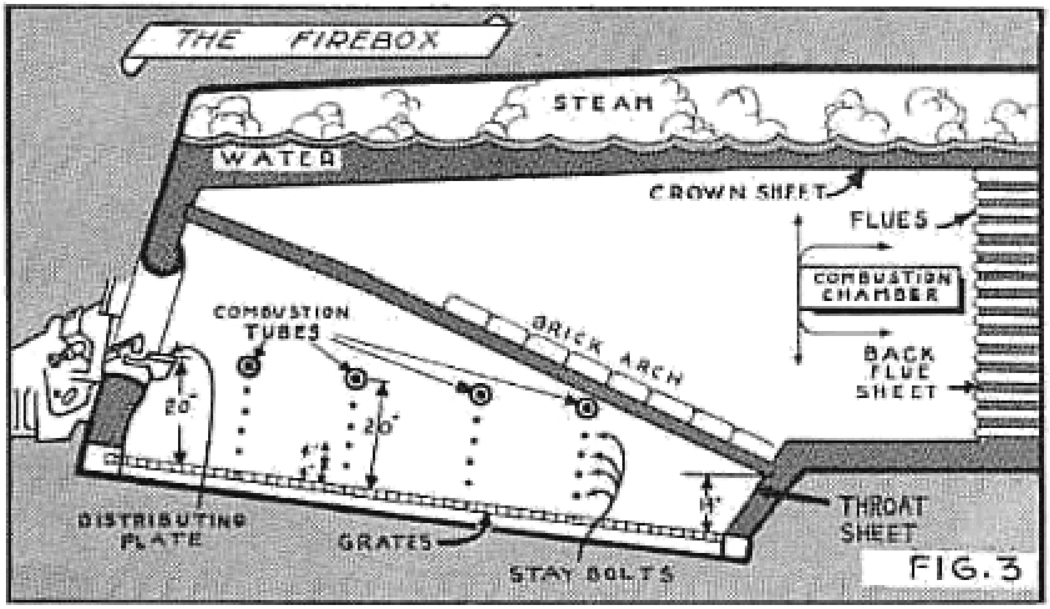


FIG. 3

The arch also promotes considerable protection against leaking flues by causing a more even distribution of the heat over the flue sheet which forms the front of the firebox.

A sudden draft of cold air caused by a light spot in the fire or by opening the fire door does not pass directly through a few flues only, but is more evenly distributed by the arch. This is illustrated in Fig. 3.

FLUES

The flues (Fig. 1-A), attached to the front sheet of the firebox and to the back sheet of the smokebox, extend the length of the circular shell midsection of the boiler. They carry the gaseous products of combustion from the firebox to the smokebox in the front section of the boiler. The combustion gases are very hot, and play an important part in heating the water which surrounds the boiler flues and in superheating the steam in the superheater units.

A superheater locomotive has a number of large boiler flues in which steam superheating units are installed (Fig. 1-C). These units pass the saturated steam four times through the flues and raise the temperature of the steam from 300-400 degrees to 600-750 degrees.

CAUSES OF LEAKING FLUES

Anything that will cause the temperature of one area to be different from that of the surrounding areas may cause leaking flues. If some flues do not heat as much as others, or cool more rapidly than others, they will exert a pull on the flue sheets (Fig. 1); likewise the hotter, expanded flues will resist the pull. This strain tends to loosen the flues in the flue sheets. Plugged flues, uneven distribution of draft, and sudden changes in the firebox temperature, all put a strain on the boiler flues and tend to cause leaks.

Some conditions that may cause leaking flues are the following:

1. A hole in the fire.
2. The fire door being open too long.
3. Plugged flues.
4. Rapid changes in firebox temperature, especially if occurence is repeated.
5. Using the blower too hard while cleaning the fire with the fire door open.
6. Injecting water into the boiler too rapidly when the fire is low.
7. Using the feed-water pump while the locomotive is idle.
8. Dirty or sooted flues.
9. Scale on the tubes.

FIRE DOORS

The back sheet of the firebox carries the fire door. Three types of automatic fire doors are used on locomotives: the vertical (Fig. 4); the clam-shell (Fig. 5); and the butterfly (Fig. 6).

They are operated by air and are controlled by a foot pedal. There is an adjustment of the exhaust plug to prevent slamming.

Air-operated doors can be operated by a hand lever (Fig. 6) after shutting off the air supply to the door-operating cylinder by closing the valve which is put in the air line for that purpost.

The cylinders of the power door should be lubricated with engine oil or car oil; the slides should be lubricated with water.

CAUTION: If it is necessary to place an arm or hand inside the door, the safety latch should be used or the door securely blocked open.

STAYBOLTS

Staybolts (Fig. 7) are used to support the inner and outer sheets of steam boilers to prevent the sheets from being forced apart by the steam pressure. They are subjected to considerable strain because the inner plate gets much hotter and expands more than the outer plate. It is important for the fireman to consider the expansion and contraction that takes place when the heat in the firebox is increased or decreased, and to control his fire to avoid rapid changes and uneven changes in firebox temperature.

Staybolts sometimes break and when they do they usually break at the outer sheet. A telltale hole (Fig. 7-A) is drilled in stayblots subjected to severe stresses so that a broken bolt can be discovered by leaking water or steam.

Flexible staybolts are designed so that one end can move (Fig. 7-B). This type is used where the sheets to be supported are subjected to considerable differences in temperature and where rigid staybolts would break frequently. A telltale hole may be used in flexible staybolts.

Safety requires that the engineman watch for broken staybolts and report them.

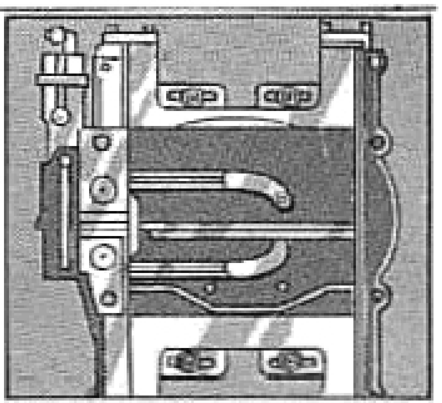


FIG. 4

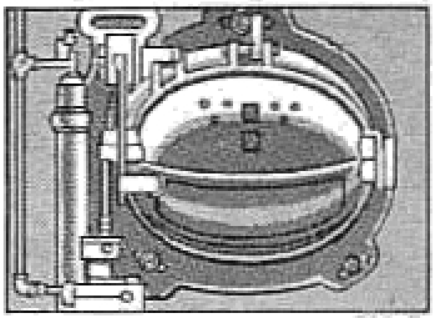


FIG. 5

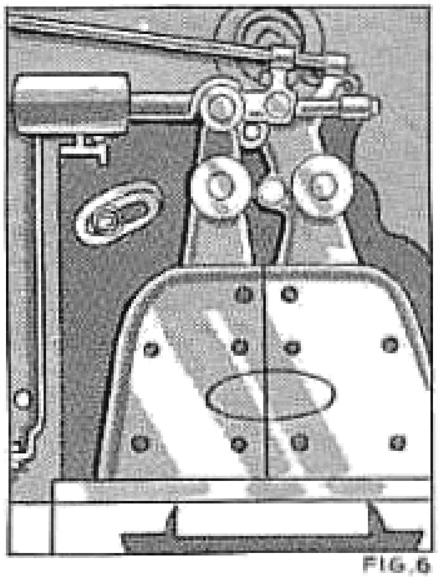


FIG. 6

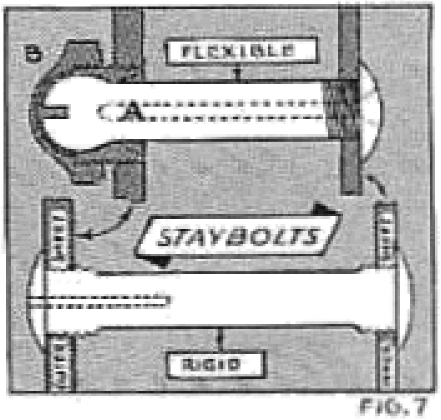


FIG. 7

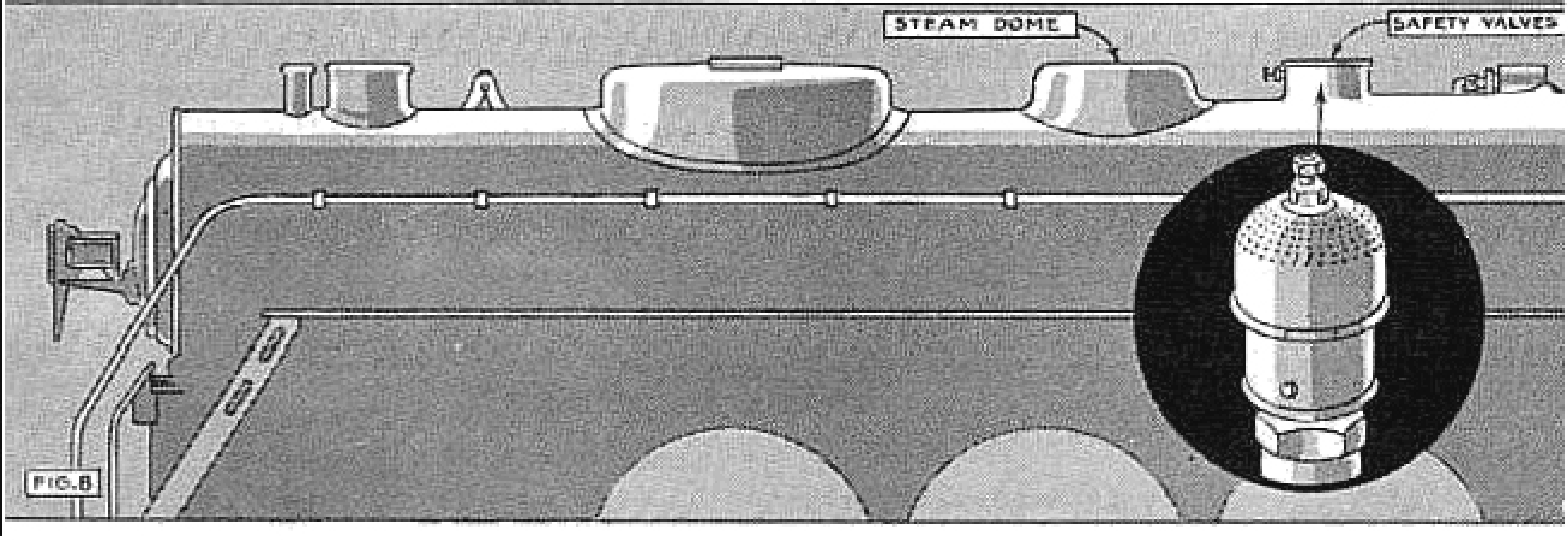


FIG. 8

STEAM DOME

Locomotive boilers are provided with a steam dome (Fig. 8) to provide a space from which to obtain steam in as dry condition as possible.

SAFETY VALVES

Safety valves (Fig. 8) are automatic safety devices located in the highest point on the boiler. They give warning, by "popping" or "blowing off," that the maximum boiler pressure as indicated by the badge plate has been reached. They limit the boiler pressure by automatically opening and allowing steam above the maximum pressure to escape. Locomotives are equipped with either two or three safety valves which are set to pop off at different pressures with a difference of two or three pounds.

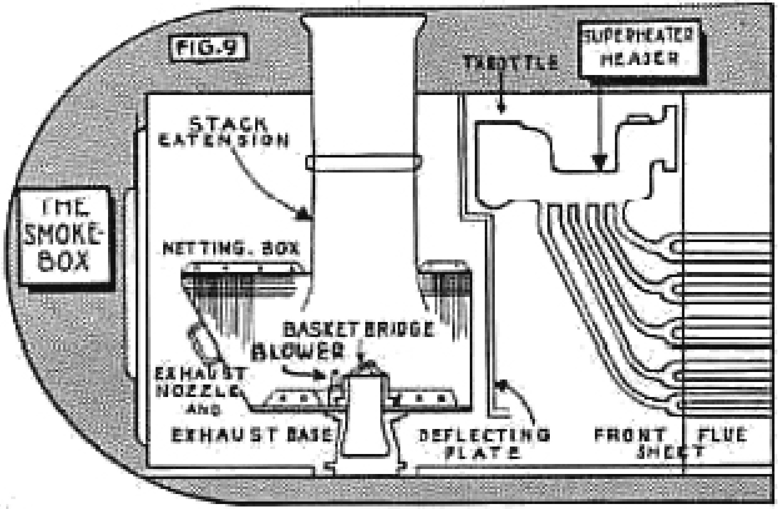
It is good practice to check the steam-pressure gage with the badge plate and notice whether or not the safety valve "pops" at the maximum pressure. Popping can be avoided by careful firing and by proper boiler pumping.

THE SMOKEBOX

The smokebox (Fig. 9), usually called the front end, contains the appliances which control, to a large extent, the draft through the firebox.

The important draft appliances in the smokebox are the smokestack extension, the exhaust-steam nozzle, the basket bridge, the blower nozzle, and the diaphram (or the deflecting plate).

The burned gases from the firebox pass through the boiler flues into the smokebox and out the stack.



The exhaust steam, as it passes through the exhaust standard and exhaust tip and out through the smoke stack, creates a vacuum in the smokebox. This creates the draft of air through the grates which is so necessary for good combustion in the firebox. The amount of draft depends on the amount of exhaust steam being discharged through the smoke stack. The amount of exhaust steam depends on the conditions under which the locomotive is being worked. Thus, the draft through the fire bed is automatically increased and decreased as the need for more or less steam varies.

The blower (Fig. 9) is used to create a draft when the locomotive is not being worked and no exhaust steam is passing through the smoke stack. Refer to Unit I-13 for a description of the blower.

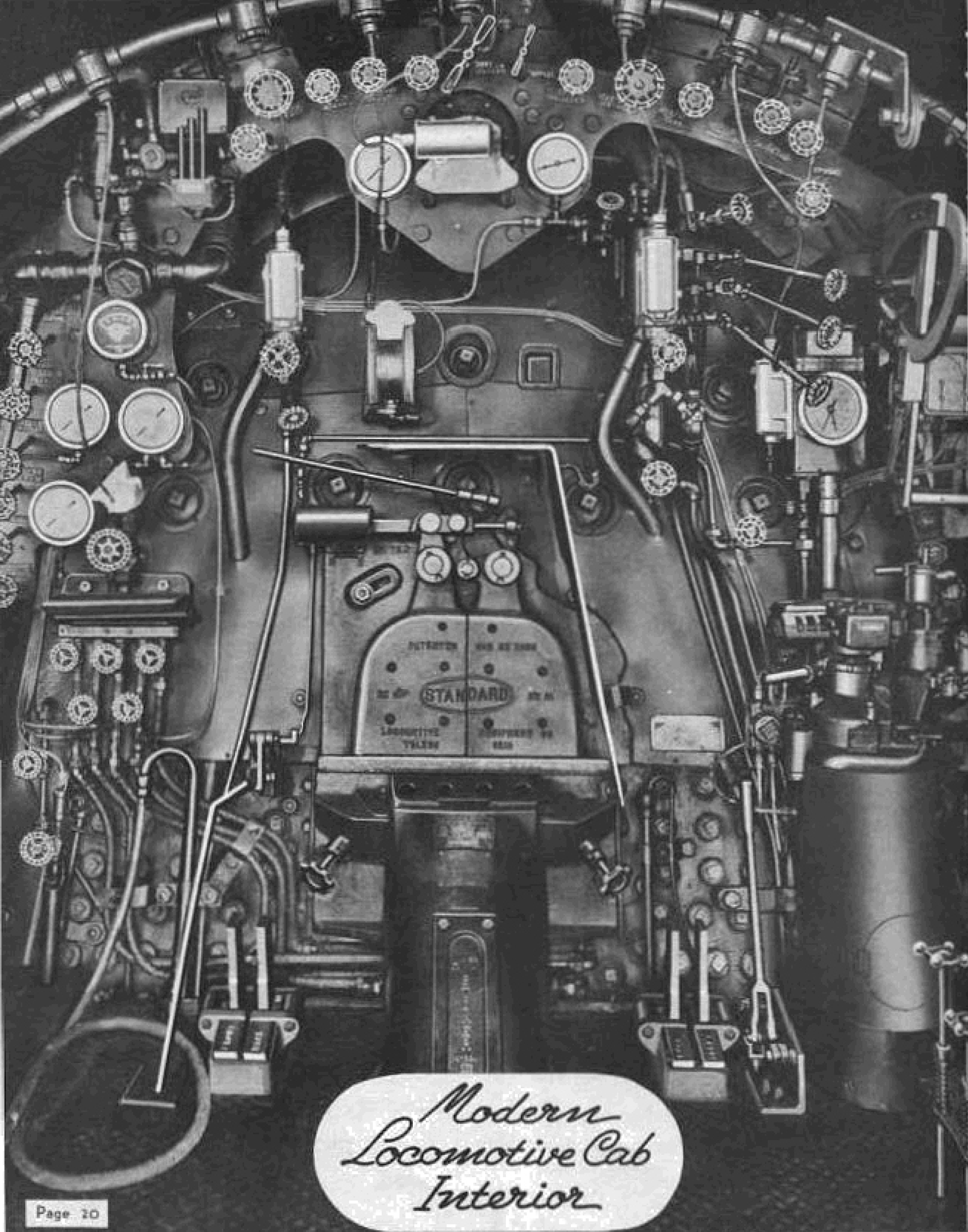
The netting (Fig. 9) prevents sparks from being thrown from the stack. A plugged netting is indicated by excessive smoke, a lack of action in the fire, a rapid drop in steam pressure, smoke or gases coming out of the firebox, and an ineffective blower. The fireman should look for indications of plugged nettings.

Steam leaks in the smokebox, caused by leaking steam pipes or nozzle-base joints, will permit steam to fill space in the smokebox, will destroy the vacuum and thereby decrease the draft through the fire, causing it to burn red.

Air leaks in the smokebox can result in two bad conditions: (1) the draft through the fire bed is reduced, and (2) the smokebox may be burned or warped by combustion occurring in the smokebox itself. Air leaks must be promply reported.

SELECTED REFERENCES

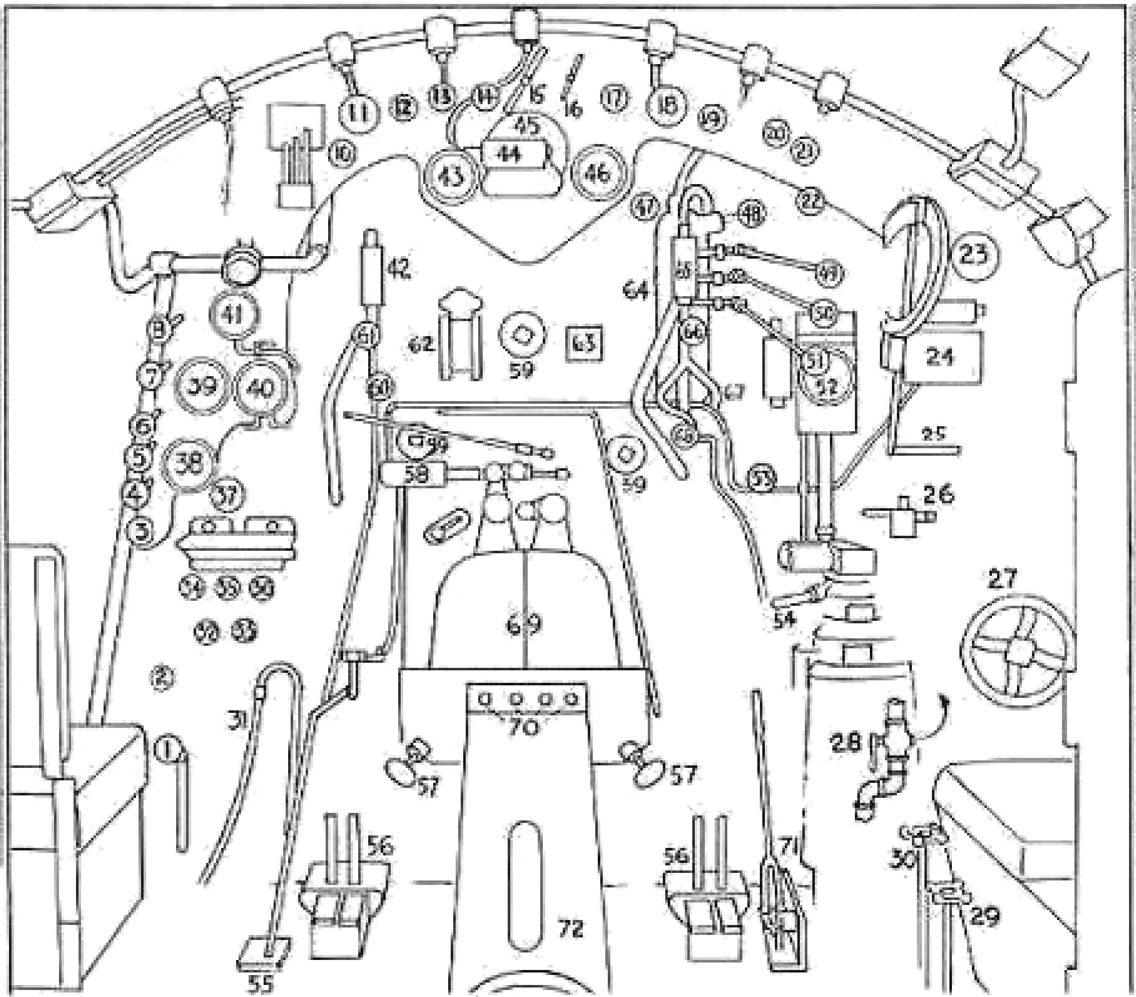
Instructions for the Preparation and Maintenance of Locomotive Fires	New York Central System
Traveling Engineers' Examination Book	Railway Fuel and Traveling Engineers' Association
Locomotive Cyclopedia	Simmons, Boardman Pub. Co.
Examinations for Firemen and Hostlers	New York Central System



Modern Locomotive Cab Interior

Courtesy of Lima Locomotive Works, Incorporated

1. Sprinkling Hose Valve
2. Cold-Water Pump Heater Valve
3. Pump-Heater Valve
4. Pump-Throttle Valve
5. Stoker Steam Valve
6. Stoker-Throttle Valve
7. Smoke-Consumer Valve
8. Blower Valve
9. Train-Control Acknowledgment Whistle
10. Water-Pump Steam Valve
11. Steam Heat Valve
12. Stoker Steam Valve
13. Water-Pump Heater Valve
14. Generator Steam Valve
15. Steam Turret Valve
16. Left Water-Gage Valve
17. Coal-Sprinkler Valve
18. Cab and Water-Scoop Heater
19. Smoke-Consumer Steam Valve
20. Coal-Pusher Steam Valve
21. Injector Steam Valve
22. Air pump
23. Right Blower Valve
24. Air Gage
25. Throttle Lever
26. Ind. Brake-Valve Handle
27. Power Reverse Gear
28. Water-Scoop Cut-Out Cock
29. Injector Supply
30. Injector Overflow
31. Squirt Hose
32. Left-Front Jet Valve
33. Right-Front Jet Valve
34. Left-Back Jet Valve
35. Fine-Coal Jet Valve
36. Right-Back Jet Valve
37. Intermediate Jet Valve
38. Fine-Coal Gage
39. Stoker-Engine Gage
40. Right and Left Front Jet Gage
41. Feed-Water Heater Gage
42. Left Water Glass
43. Train-Heat Gage
44. Light
45. Pyrometer
46. Tender Tank Gage
47. Air-Supply Valve to Tender Tank Gage
48. Water-Glass Steam Valve
49. Upper Gage Cock
50. Middle Gage Cock
51. Lower Gage Cock
52. Valve Pilot Gage
53. Fire-Door Air Valve
54. Auto. Brake-Valve Handle
55. Fire-Door Operating Pedal
56. Grate Levers and Locks
57. Vane Adjusting Wheels
58. Fire-Door Cylinder
59. Washout Plugs
60. Water-Glass Drain Valve
61. Water-Glass Water Valve
62. Boiler-Pressure Gage
63. Badge Plate
64. Water Column
65. Right Water Glass
66. Water Valve
67. Water-Glass Drain Valve
68. Water-Column Drain Valve
69. Fire Door
70. Peepholes
71. Injector Operating Lever
72. Stoker Elevator Pipe



HOW TO INSPECT THE FIRE

OBJECTIVES

1. To explain the safety precautions to be observed when inspecting fires.

2. To stress the importance of frequently inspecting the fire.

3. To tell what should be done before inspecting the fire.

4. To explain what to look for when inspecting a fire.

INTRODUCTORY INFORMATION

Many bad fire conditions can be prevented before they develop into serious difficulties if the fireman forms the habit of frequently inspecting the fire.

There are so many factors which have a tendency to change fire conditions that frequent inspection of the fire is absolutely necessary. Shortening the cut-off, or "easing off" on the throttle, requires a decreased amount of coal in the firebox and decreases the amount of water required to maintain the boiler water at the proper level. Firebox conditions are changed when the coal changes from lump to slack or from slack to lump, or if the condition of the coal changes from dry to wet or from wet to dry. Jet pressures have an effect on the condition of the fire. The stoker speed and the stoker-jet pressures must be adjusted if the condition of the coal changes or if the load conditions change.

By frequent inspections the fireman can detect the formation of clinkers, and can prevent plugged arches, banks, and holes. Any condition in the firebox which causes unbalanced draft, tends to cause a carry-over of cinders and unburned coal which may result in a plugged front-end netting. Through frequent inspection most difficulties can be detected and corrected before they become serious.

An experienced fireman will make all of the inspections described in this unit in a very short time and will then take the necessary steps to correct any bad conditions revealed.

EQUIPMENT REQUIRED

The equipment provided should comply with local instructions.

Monkey Wrench
Alligator Wrench
Scoop Shovel
Jet Hook
Slide Hook
Fire Rake
Packing Hook
Flags (Red and White)
Packing Spud
Wire Torch
Torpedoes
Shaker Bar
Grease Gun
Coal Pick
Lanterns (Red and White)
Fusees
Oil Can and Waste
Drinking Water Container

HOW TO INSPECT FIRES

PROCEDURE

Examine the fire frequently by following the procedures described in this unit, so that the exact conditions in the firebox will be known at all times. Frequent inspection gives the fireman a chance to correct troubles before they affect performance.

BEFORE THE DOOR IS OPENED

1. Observe the pressure indicated on the stoker-engine gage. Knowing the pressure before shutting off the stoker will give the fireman a basis for setting the stoker speed when stoker operation is resumed. After a little experience the fireman will be able to judge the best pressure for different operating conditions (Fig. 1).

2. Shut off the stoker by closing the stoker throttle (Fig. 1).

   CAUTION: The fire door should not be opened for fire inspection until the supply of coal to the firebox is stopped and the gases have been allowed to burn off.

3. Observe the pressure on the stoker-jet pressure gage (Fig. 1) so that jet operation may be resumed with the same pressure at which it was operating before being shut off.

4. Shut off the stoker-jet intermediate valve (Fig. 1).

5. Apply the smoke consumer by opening the valve shown in Fig. 1). (Refer to Unit I-13 for a descrip-

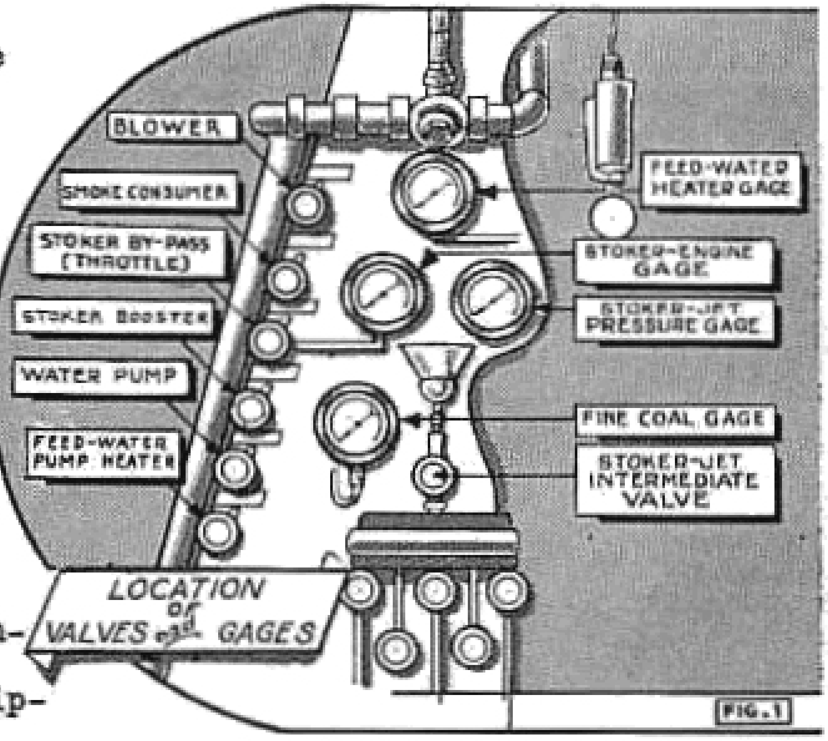


FIG. 1

tion of the smoke consumer.)

CAUTION: Never try to inspect the fire before the gases in the firebox have burned off. The smoke consumer assists in burning off the gases and makes a complete visual inspection of conditions in the firebox possible.

6. Observe the pressure recorded on the boiler-pressure gage, for if the boiler pressure changes it may be necessary to change the stoker-jet pressure to compensate for the change in pressure.

INSPECT THE WHOLE FIRE

7. Open the fire door.

8. Take an over-all view of the condition of the fire. Experience will enable the fireman to judge the general condition of his fire quickly.

9. Check the depth of the fire, which should be ten inches or less, by gaging the distance between the fire and the distributing plate of the BK and HT stokers and also by the smoke-consumer holes. The distributing plate and smoke-consumer holes are approximately twenty inches from the grates. The staybolts, which are four inches apart in the side sheet, can also be used to check the depth of the fire (Fig. 2). (Refer to Units P-3, P-6, P-7, and P-8 for information on factors that determine the correct depth of the fire.)

10. Inspect the fire for light spots. Light spots and holes (Fig. 3) cause a drop in boiler pressure, and the increased draft through that portion of the fire may cause a carry-over of cinders and coal which may plug the front-end nettings.

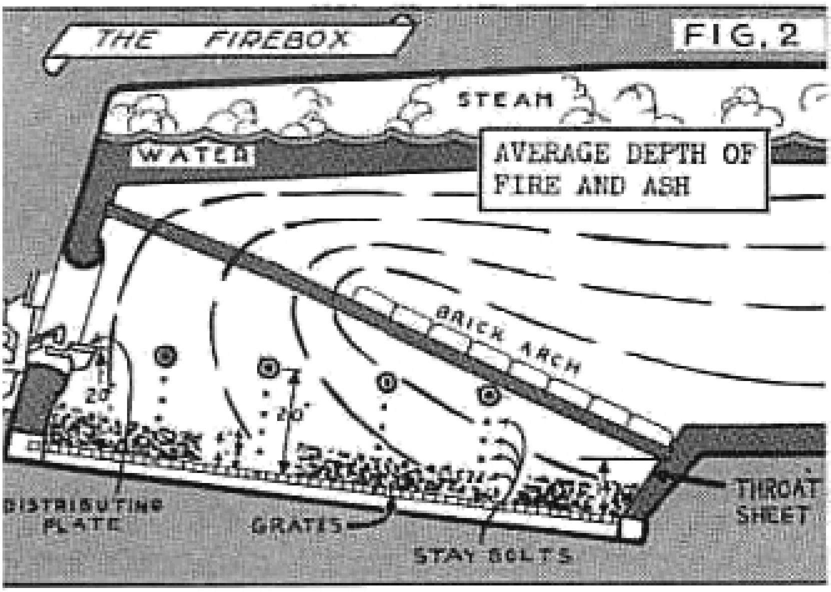


FIG. 2

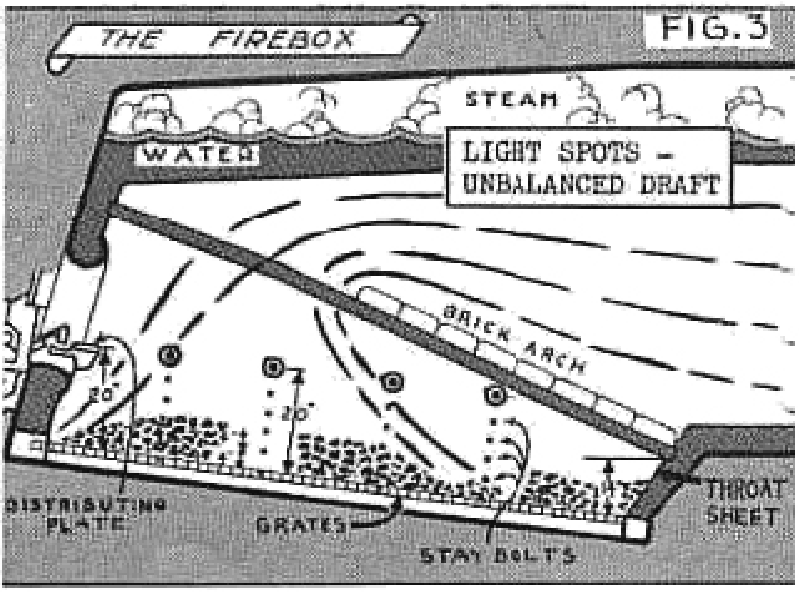
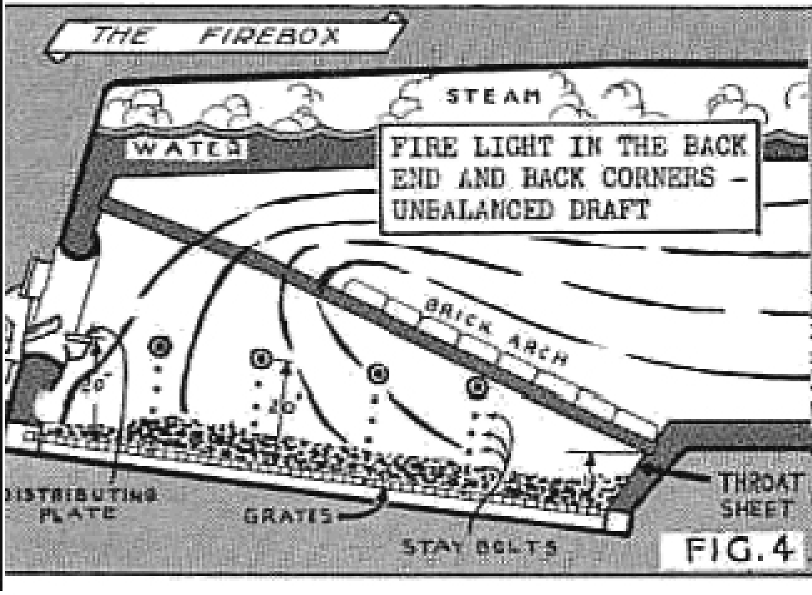
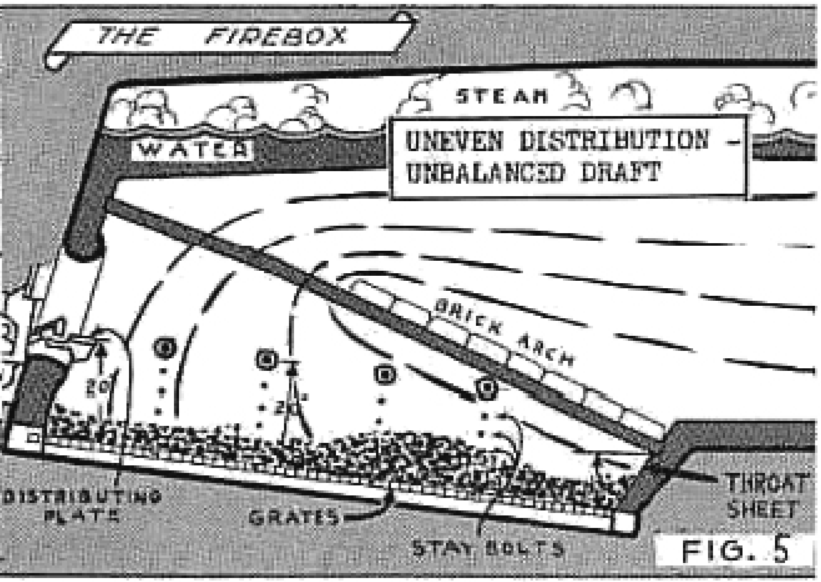


FIG. 3



FIRE LIGHT IN THE BACK END AND BACK CORNERS - UNBALANCED DRAFT

FIG.4



UNEVEN DISTRIBUTION - UNBALANCED DRAFT

FIG. 5

11. Inspect the condition of the fire in the back end and in the back corners (Fig. 4). The back corners are often a source of trouble because the grates slant downward toward the front and the vibration of the locomotive causes the fire to creep off the back grates.

12. Look for high spots, drifts, or banks (Fig. 5) which are the result of improper distribution and failure to inspect the fire frequently. High spots develop into banks which are one of the common causes of clinkers.

CORRECT BAD CONDITIONS REVEALED BY INSPECTION

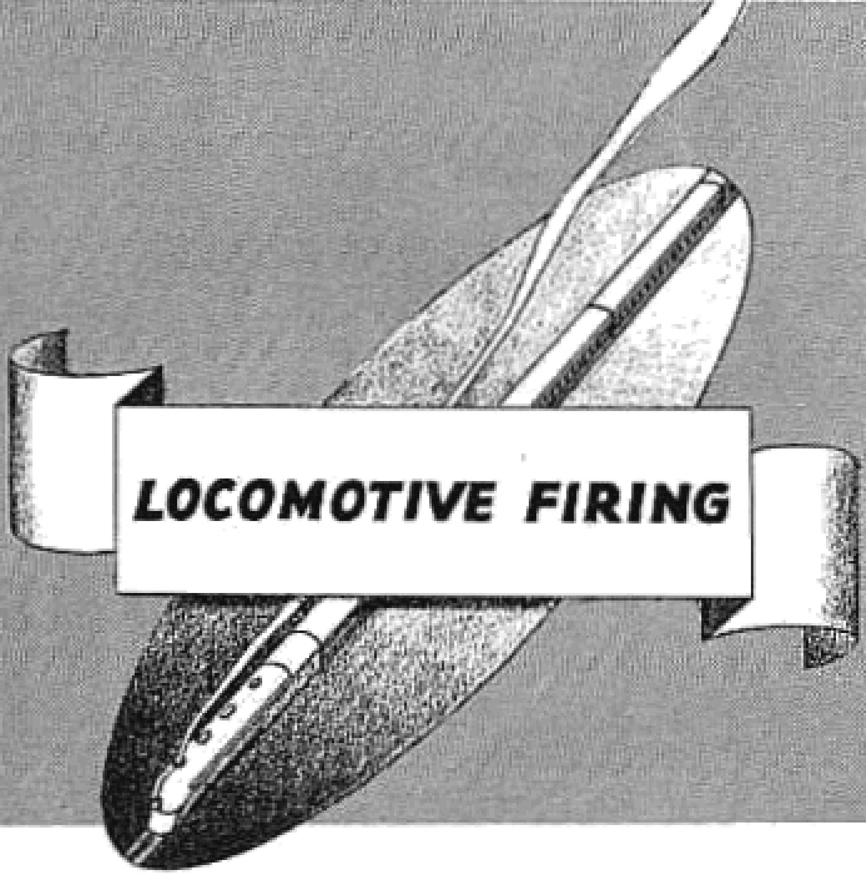
13. Correct bad fire conditions by following procedures outlined in Unit P-8, How to Correct Bad Fire Conditions.

14. Close the fire door.

15. Resume stoker operation. Increase the stoker speed if the boiler pressure should be raised. Reduce the stoker speed if the demand for steam is decreased.

16. Resume stoker-jet operation. Regulate the jet-manifold pressure to the same pressure that was being used before the fire was inspected unless the condition of the fire indicates that more or less pressure is required to maintain an even depth of fire over the grates.

17. Make frequent inspections to make certain that the fire is in good condition and that any bad conditions that may have been discovered have been corrected.



LOCOMOTIVE STOKERS

UNIT I-3
Pages 29-31

UNIT P-3
Pages 32-38

UNIT I-4
Pages 39-43

UNIT P-4
Pages 44-49

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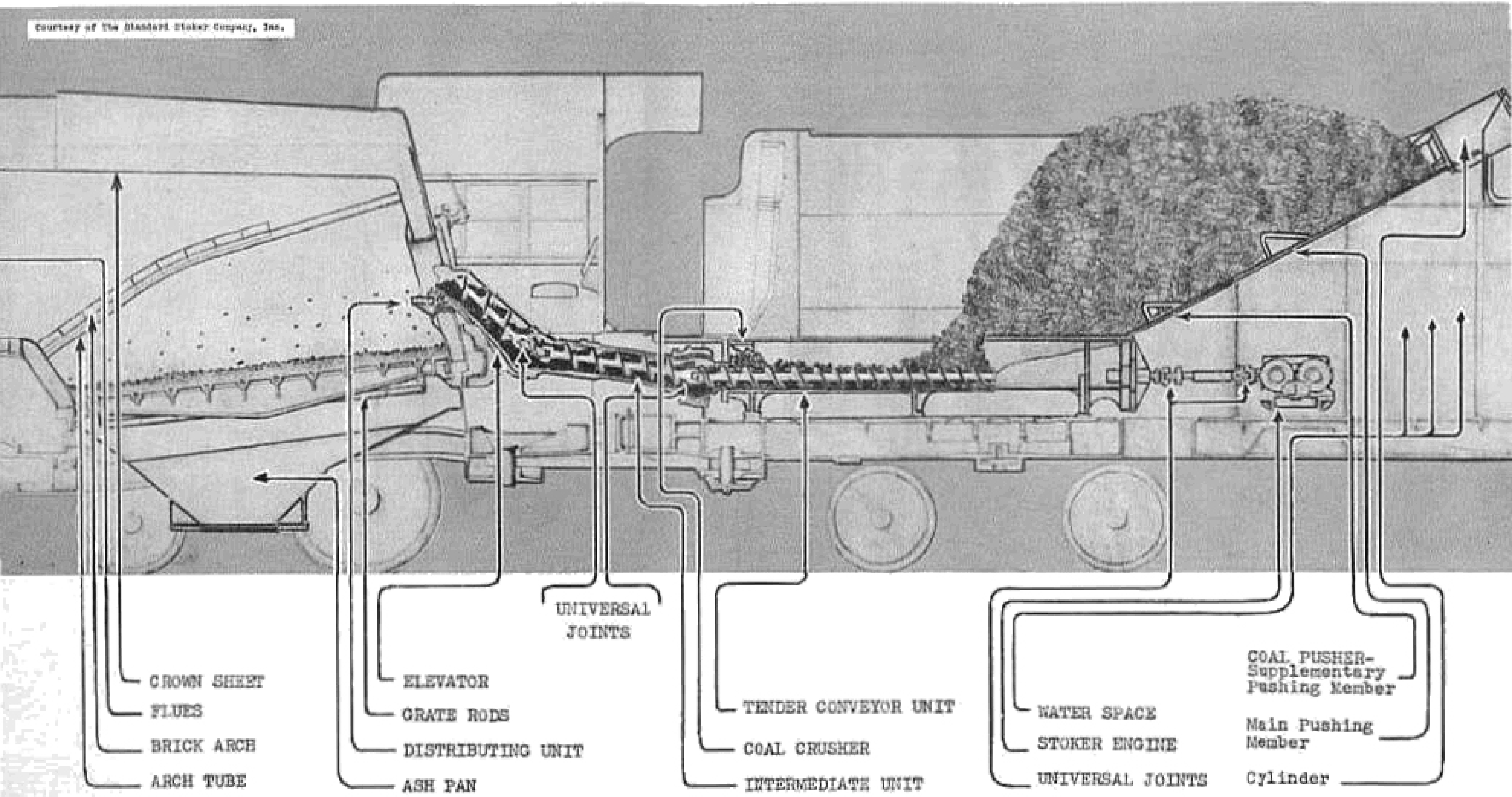
STATE EDUCATION DEPARTMENT
BUREAU of INDUSTRIAL AND
TECHNICAL EDUCATION

LOCOMOTIVE STOKER AND COAL PUSHER


Courtesy of The Standard Stoker Company, Inc.

DESCRIPTION OF STOKER OPERATION

OBJECTIVES

1. To explain the principle of operation of the mechanical stokers used on locomotives.
2. To acquaint the fireman with the general construction of the HT mechanical stoker.
3. To explain the function of the stoker units.

INTRODUCTORY INFORMATION

It is important for the fireman to understand thoroughly how the mechanical stoker system operates. A knowledge of the operation of the complete coal-delivery system from the tender to the firebox will help him solve many of the problems encountered in his job of firing the locomotive.

The mechanical stoker conveys the coal from the trough in the tender, through the crusher to the intermediate conveyor unit, and up through the elevator pipe by means of a screw. The coal is deposited on the distributing plate in front of the jet plate at the fire door by the elevator screw. From the jet plate the coal is blown over the fire by a series of jets of steam emitted from the jet plate and controlled by five jet valves.

There are a number of types of mechanical stokers in use, but all work upon the same basic principle. The HT stoker (Fig. 1) consists of five principal units: the Stoker Engine, the Tender Conveyor Unit, the Telescopic Intermediate Unit, the Elevator Pipe, and the Distributing Unit.

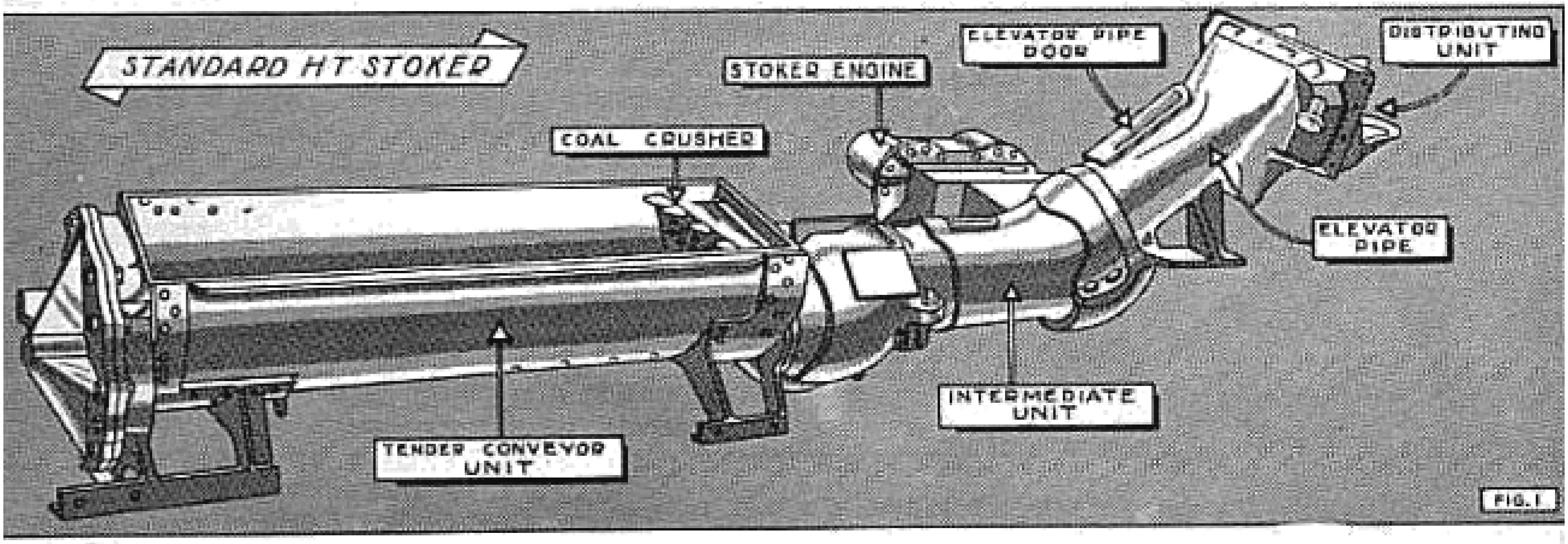


FIG. 1

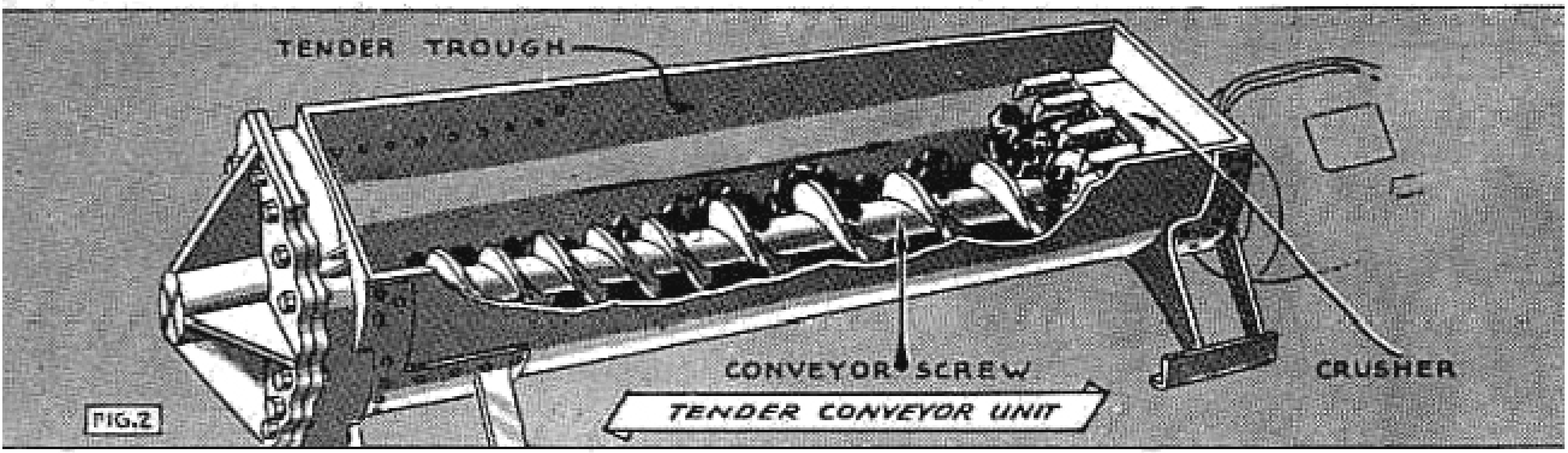


FIG.2

THE TENDER CONVEYOR UNIT

The tender conveyor unit (Fig. 2) is fastened to the tender frame and is located so that practically all of the coal in the tender will be fed into the conveyor. A coal pusher located in the rear of the tender can be used to push the coal forward so as to provide a constant supply to the conveyor.

The conveyor has a rotating screw which is driven by the stoker engine. The screw carries the coal to the crusher at the forward end of the conveyor where it is broken into pieces small enough to be fired satisfactorily.

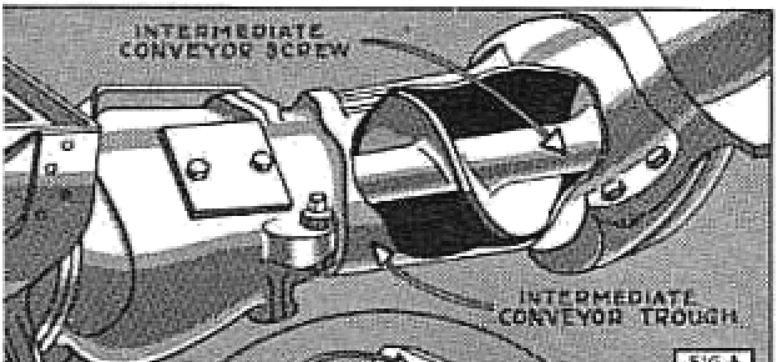


FIG.3

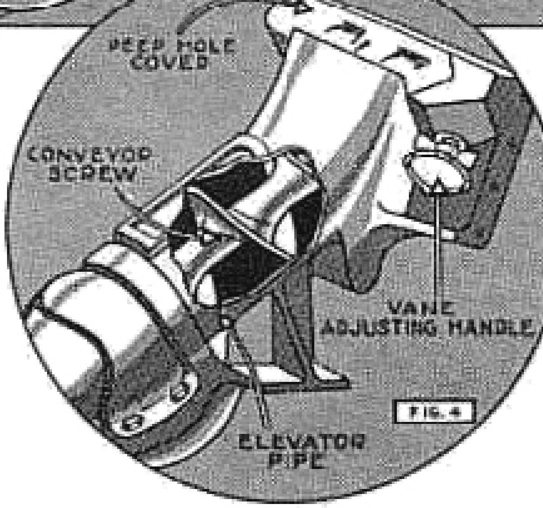


FIG.4

THE INTERMEDIATE UNIT

The intermediate unit (Fig. 3) consists of two telescoping tubes connected to the tender trough and the elevator pipe by ball-and-socket joints to provide flexibility between the tender and the locomotive. The intermediate conveyor screw is flexibly connected to the tender and elevator screw by universal joints to provide freedom of action when the locomotive is on a curve.

THE ELEVATOR PIPE

The elevator pipe (Fig. 4) and the elevator screw are connected to the intermediate unit by a ball-and-socket and a universal joint just below the deck of the cab.

THE DISTRIBUTING UNIT

The distributing unit (Fig. 5) consists of the distributing table, the jet plate, and vanes. The distributing table, which is fastened to the jet plate, has deflecting ribs on the top. The distributing table is protected from overheating by air deflected against the underside by an air-sealing apron. The jet plate is provided with a series of holes through which steam is blown to distribute the coal over the fire bed (Fig. 6).

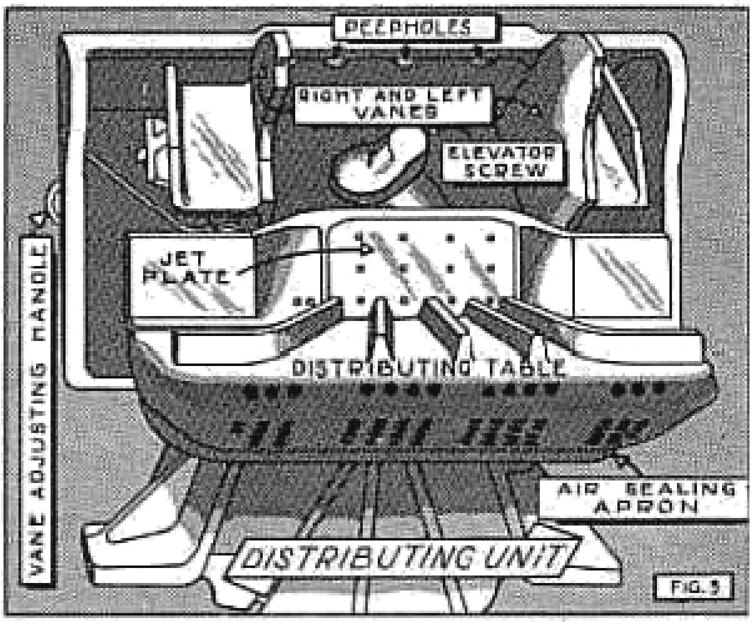


FIG. 5

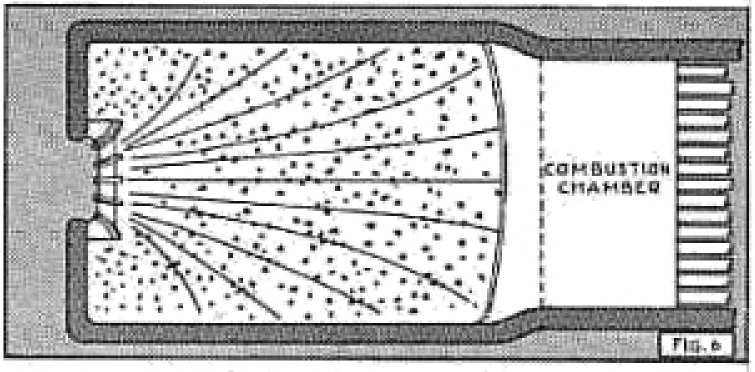


Fig. 6

THE STOKER ENGINE

The stoker engine (Fig. 7) is operated by steam and is used to drive the conveyor and elevator units through reduction gears. It can be located either on the tender or on the locomotive. The engine speed is controlled by a throttle valve to increase or decrease the amount of coal delivered to the distributing table according to the demand of the fire. The pulsations of the pointer on the steam-indicator gage give a good indication of the running speed of the stoker.

The engine is reversible so that obstructions can be removed from the stoker by reversing the direction of rotation of the conveyor screws.

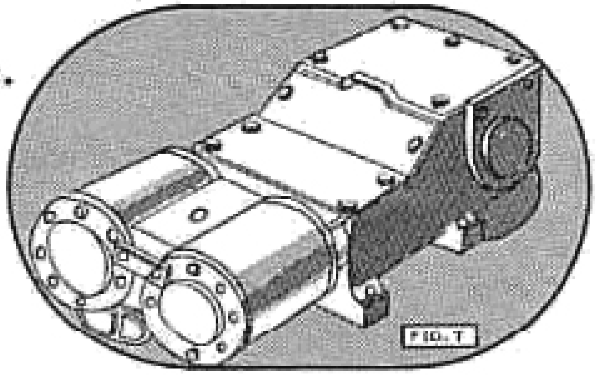


FIG. 7

SELECTED REFERENCES

Instructions for the Preparation and Maintenance of Locomotive Fires	New York Central System
Traveling Engineers' Examination Book	Railway Fuel and Traveling Engineers' Association
Examinations for Firemen and Hostlers	New York Central System

Instruction Manuals supplied by stoker manufacturers

HOW TO OPERATE THE STOKER

OBJECTIVES

1. To call attention to the safety precautions to be observed when checking for faulty operation of the stoker.
2. To point out the importance of the stoker speed in maintaining the fire.
3. To tell how to operate the stoker engine.
4. To explain how to remove obstructions from the stoker.
5. To explain the care of the stoker when preparing the engine for the enginehouse.

INTRODUCTORY INFORMATION

The function of the mechanical stoker is to deliver coal from the tender trough to the distributing plate located inside of the fire-door opening. The fireman can operate the stoker much more successfully if he understands how the system operates.

The stoker mechanism is driven by a reversible type of steam engine which can be operated at any desired speed. The speed of the stoker engine determines the amount of coal which will be delivered to the distributing plate. Stoker speeds should be changed as the grade, size, and condition of coal varies, and when changes in locomotive speed or train load create a demand for more or less steam.

Although stoker failures resulting from obstructions are not common, the fireman may be confronted with this problem. Foreign substances sometimes get into the coal and become lodged in the conveyor mechanism. This causes the stoker to slow down or stall. This difficulty can be detected before serious trouble results, if the fireman forms the habits of observing the stoker gage frequently and of watching the coal supply through the peepholes.

EQUIPMENT REQUIRED

The equipment provided should comply with local instructions.

Monkey Wrench
Alligator Wrench
Scoop Shovel
Jet Hook
Wire Torch
Torpedoes
Shaker Bar
Grease Gun

Slide Hook
Fire Rake
Packing Hook
Flags (Red and White)
Packing Spud
Coal Pick
Lanterns (Red and White)
Fusees
Oil Can and Waste
Drinking Water Container

HOW TO OPERATE THE STOKER

PROCEDURE

The purpose of this unit is to explain the general operation of stokers, making the instruction broad enough so that the fireman will know how to apply the information to all types of stokers.

Variations in the construction of different types of stokers are explained in Unit I-4, Description of Different Kinds of Stokers.

BEFORE LEAVING TERMINAL

1. Check the lubrication of the stoker mechanism and check the oil in the stoker-engine bed before leaving the terminal. A compartment oil box is located on the side of the tender cistern near the coal gates; from this box pipes lead to the various bearings. Fill the oil box with car or engine oil at the beginning of the trip. Do not use valve oil as it will clog the lines. The universal joints and slip-shaft joints should be oiled with a hand oiler; use either engine or car oil.

   NOTE: Lubricate the stoker according to local instructions. In some cases the stoker will be lubricated by the terminal mechanic. The fireman, however, should check to see that the stoker mechanism is properly lubricated.

2. Check the grade, size, and condition of the coal at the point of delivery in the tender trough. The kind of coal will give an indication of the stoker speed and stoker-jet pressures required.

   NOTE: Higher pressure is needed to run the stoker engine when lump coal must be crushed by the stoker than when slack coal is being used.

3. Prepare the fire by hand firing as explained in Unit P-1, How to Prepare the Fire.

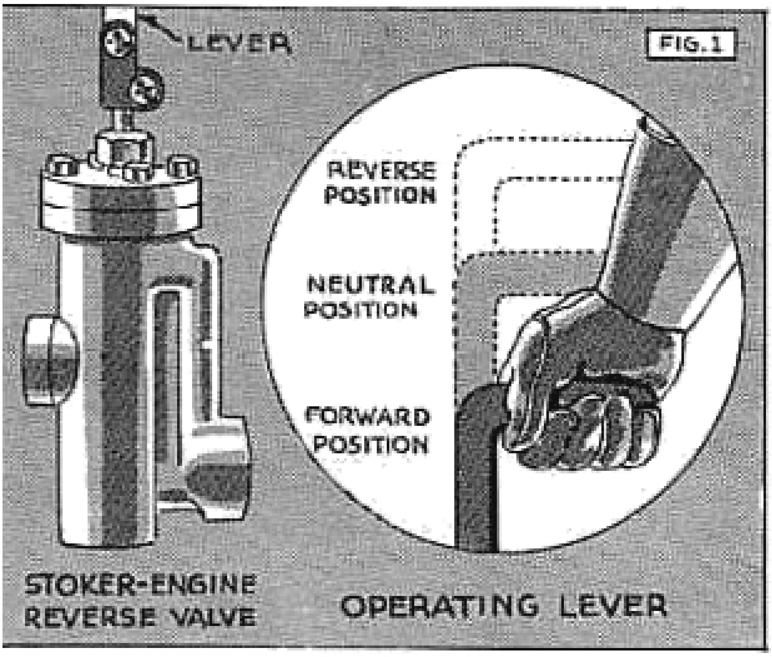


FIG. 1

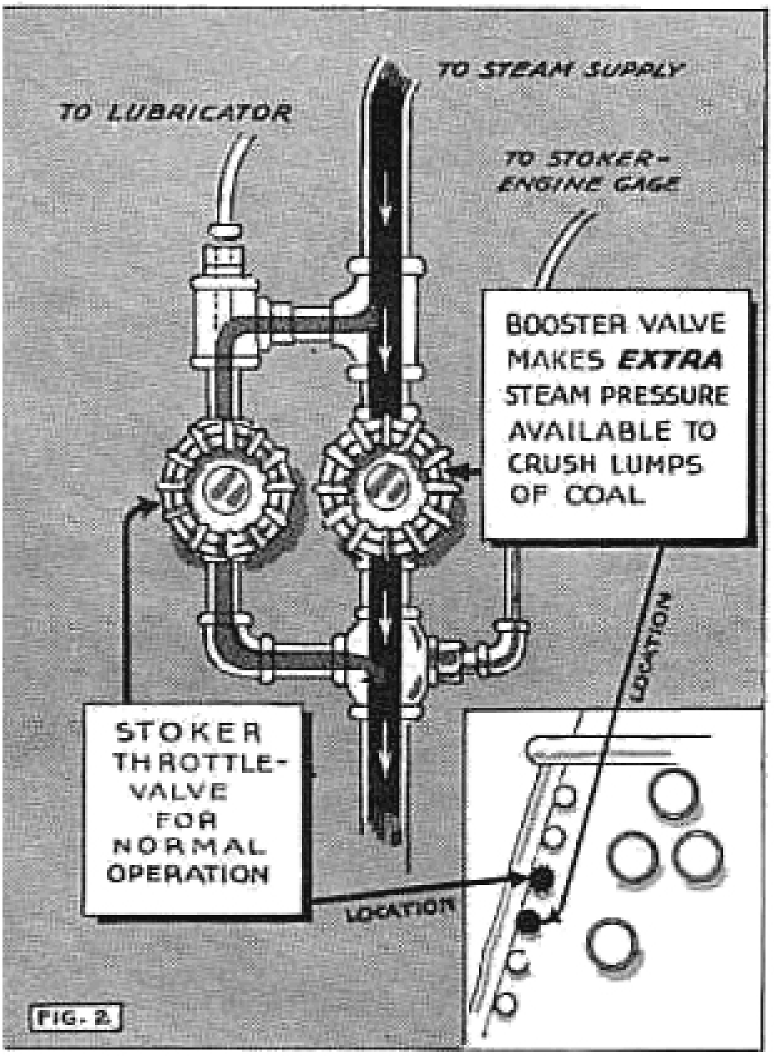

TO STEAM SUPPLY
TO LUBRICATOR
TO STOKER-ENGINE GAGE
BOOSTER VALVE MAKES ***EXTRA*** STEAM PRESSURE AVAILABLE TO CRUSH LUMPS OF COAL
STOKER THROTTLE-VALVE FOR NORMAL OPERATION
LOCATION
LOCATION

FIG. 2

TO START THE STOKER

4. Observe the position of the lever which operates the stoker-engine reverse valve. This lever (Fig. 1) may be located at the left-hand side of the cab, in front of the fireman's seat box, or on the left-front leg of the tender. The lever should be down for the forward running position and up for the reverse operation. The reverse and forward positions are indicated on a plate near the lever. The location of the reverse lever is determined by the location of the stoker engine.

   CAUTION: There are two designs of reverse valves in use. The type generally used with the HT stoker is operated as explained above. The type sometimes used with the BK and type B stoker is operated by placing the reverse lever in up position for forward operation of the stoker and down for reverse operation. The middle position is neutral for both types of valves.

5. Open the turret valve to admit steam to the stoker engine and jet-manifold lines.

6. Open the intermediate-jet valve to admit steam to the jet manifold. Check stoker-jet valves as explained on pages 45 to 49.

7. Open the stoker-engine throttle valve (by-pass valve) (Fig. 2) slowly to permit any condensate to escape through the automatic drain valve. The throttle valve controls the stoker speed which determines the amount of coal delivered to the distributing plate. The setting will de-

pend on the size, grade and condition of the coal and also on the speed and load conditions under which the locomotive is being operated.

NOTE: There are two valves in the steam line to the stoker engine (Fig. 2). One is the throttle valve used to regulate the speed of the stoker engine, and the other is a booster valve used to apply, momentarily, more steam pressure when it is necessary to increase the steam pressure to the stoker engine rapidly in order to crush exceptionally hard lumps of coal. These valves may be located in either one of the two positions shown in Fig. 2. The booster valve should be closed as soon as the lump is crushed. Normal operation is then resumed through the throttle valve.

8. Keep close watch of the speed of the stoker by observing the amount of coal being delivered to the point of delivery. The coal delivery may be observed through the peepholes located in the top of the elevator pipe.

   NOTE: The peephole cover on the discharge box should be closed except when inspecting the amount of coal being supplied to the distributor plate.

9. Adjust the stoker-engine speed to carry a fire of sufficient depth to maintain boiler pressure. Careful observation over a period of time will enable the fireman to judge the depth of fire required for different operating conditions. Do not feed too much coal — carry a light fire.

10. Adjust the jet valves as explained in Unit P-4, How to Adjust Stoker Jets.

11. Observe the pressure indicated on the stoker-engine gage. This gage assists the fireman to judge the stoker speed and to maintain an even supply of coal to the firebox. If the boiler pressure drops, the speed of the stoker engine will be affected.

   NOTE: The stoker-engine gage hand will normally fluctuate a little; but if it moves up to approximate boiler pressure and remains there, it indicates that the stoker engine has stalled. This is usually caused by an obstruction lodged in the crusher zone in the tender trough.

REMOVING OBSTRUCTIONS FROM THE HT AND BK STOKERS

12. Reverse the rotation of the stoker by placing the reverse lever in the reverse position (Fig. 1) long enough for the screw to complete four or five revolutions.

   CAUTION: See operation No. 4 on page 34 for instructions for operating the reverse lever.

13. Run the stoker in the forward direction. If the stoker does not operate, repeat the reversing procedure several times. Flushing the conveyor trough with the squirt hose will sometimes help. Proceed with operation No. 14 if the obstruction will not pass through the stoker.

14. Reverse the screw four or five turns to carry the obstruction back into the trough. Then remove the obstruction from the trough.

CAUTION: To avoid injuries, make certain that both the throttle valve and the booster valve are closed and that the reversing lever is in the neutral position while removing obstructions.

15. Resume stoker operation after the obstruction has been removed.

LOCATING AND REMOVING OBSTRUCTIONS FROM THE DUPLEX STOKER

LOCATING OBSTRUCTION

16. Shut off the steam to the entire stoker mechanism by closing the stoker-engine main valve (Fig. 3).

17. Place the stoker-engine operating lever in its non-operating position by lowering the operating rod (Fig. 4) to its lowest position.

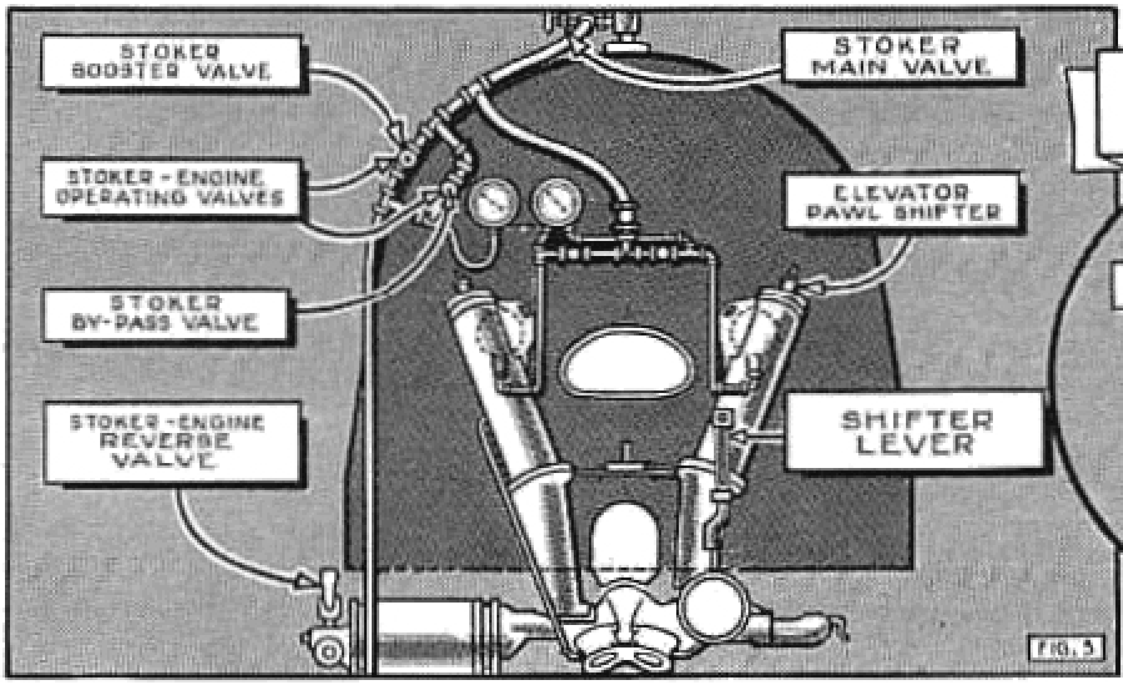


FIG. 3

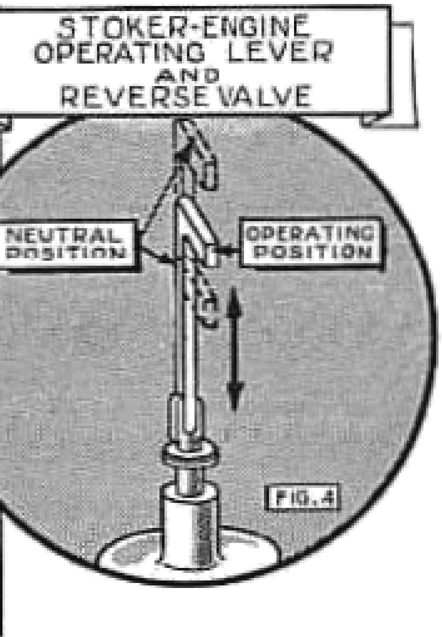


FIG. 4

18. Place the tender-conveyor reverse lever (Fig. 5) in its middle position so that the tender-conveyor screw will not operate when the elevators are being tested.

19. Raise the right elevator-pawl shifter to the neutral position (Fig. 6) so that the elevator screw will not turn while the left elevator is being tested

20. Raise the stoker-engine operating rod (Fig. 4) to the middle or operating position.

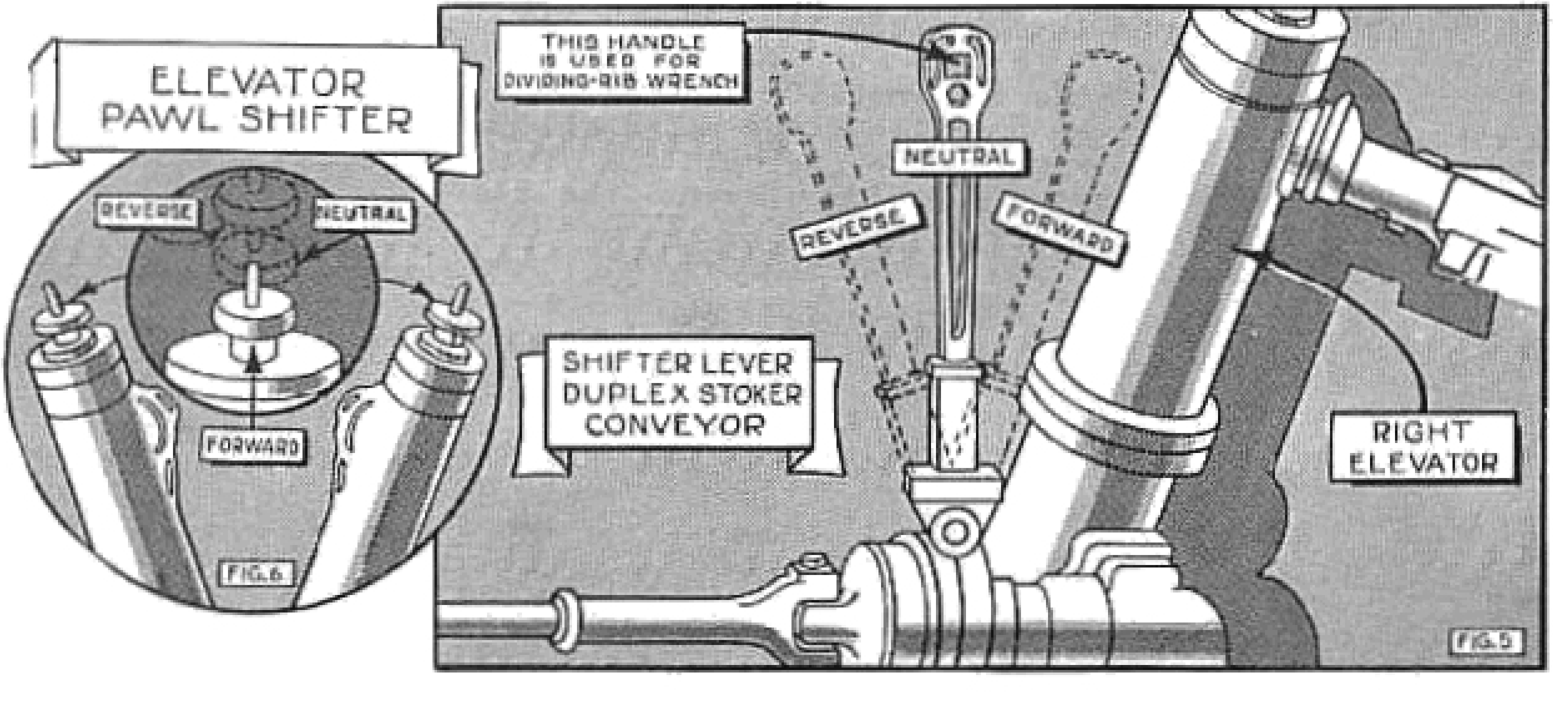
21. Open the steam-supply valve (Fig. 3) to the stoker engine slowly to ascertain if the left elevator runs freely.

22. Test the operation of the right elevator by lowering the pawl shifter (Fig. 6) to the operating position. If the stoker stops, the obstruction is in the right elevator. If it continues to operate, the obstruction is in the tender conveyor.

REMOVING OBSTRUCTIONS FROM THE TENDER CONVEYOR

23. Place the tender-conveyor reverse lever (Fig. 5) in reverse position and run the conveyor screw backwards not more than three revolutions. Then remove the obstruction which will usually be found in the crushing zone of the trough.

CAUTION: Be sure that all steam to the stoker engine is shut off and that the stoker-engine operating lever is in neutral position before attempting to remove obstructions from



any part of the stoker by hand.

REMOVING OBSTRUCTIONS FROM THE ELEVATORS

24. If the obstruction is in the elevator, place the elevator pawl (Fig. 6) in the reverse position and run the elevator in the reverse direction about three revolutions. This action will force the obstruction back down into the transfer hopper. Raise the door to the transfer hopper in the engine deck and remove the obstruction.

CAUTION: Make certain that both the throttle valve and the booster valve are closed before attempting to remove obstructions.

PREPARING ENGINE FOR THE ENGINEHOUSE

25. Before arriving at the terminal, close the tender-trough slides if the tender is so equipped, and keep the stoker in operation a short time so that the conveyor will be empty on arrival. This is to prevent wet coal from freezing in the conveyor and to provide for inspection by the enginehouse force.

26. Run the stoker engine in reverse a few revolutions to remove coal from the elevator pipe when the locomotive is placed on the enginehouse track.

27. Place the stoker-operating lever in neutral position.

28. Close the stoker-engine throttle valve (Fig. 2).

29. Close the intermediate jet valve.

NOTE: If the intermediate jet valve is not provided with a bleed hole leave the valve slightly "cracked" until the fire is dumped. This prevents the distributor plate from being overheated and also prevents the stoker-jet holes from becoming plugged.

DESCRIPTION of different kinds of STOKERS

OBJECTIVES

1. To point out that although most mechanical stokers operate on the same basic principle, there is considerable variation in the operating mechanisms and controls.

2. To point out the distintive features of different types of stokers.

INTRODUCTORY INFORMATION

The function of all mechanical stokers is to provide the firebox with coal in the proper quantity and to distribute it evenly to all parts of the fire bed.

There are a number of different stokers in use on locomotives, but all of them work on the same basic principle in that the distribution of coal is accomplished by means of jets of steam which can be regulated by the fireman so that the coal is evenly distributed to all portions of the grate area. The volume of coal on all of the different types is controlled by the speed of the stoker engine and the general operation is very similar on all types of stokers.

The general operation of the mechanical stokers is given in Unit P-3, How to Operate the Stoker.

THE STANDARD HT STOKER

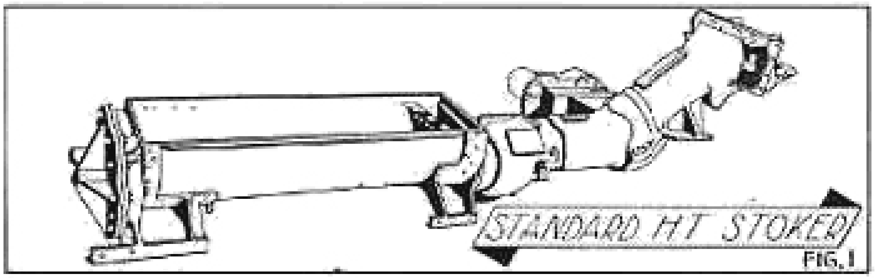
The description of the HT stoker (Fig. 1) is given in Unit I-3, Description of Stoker Operation.

FEATURES OF STANDARD BK STOKERS

The operation of the BK stoker (Fig. 2) is practically the same as the HT with the following exceptions:

1. There are no vanes at the right and left of the discharge box, and there are many other differences in the distributing units. Compare Fig. 3 on page 40 with Fig. 5 on page 31.

2. Five jet-control valves control the steam to the jets in the distributing unit of both the HT and BK stokers, but the mid-



STANDARD HT STOKER

FIG. 1

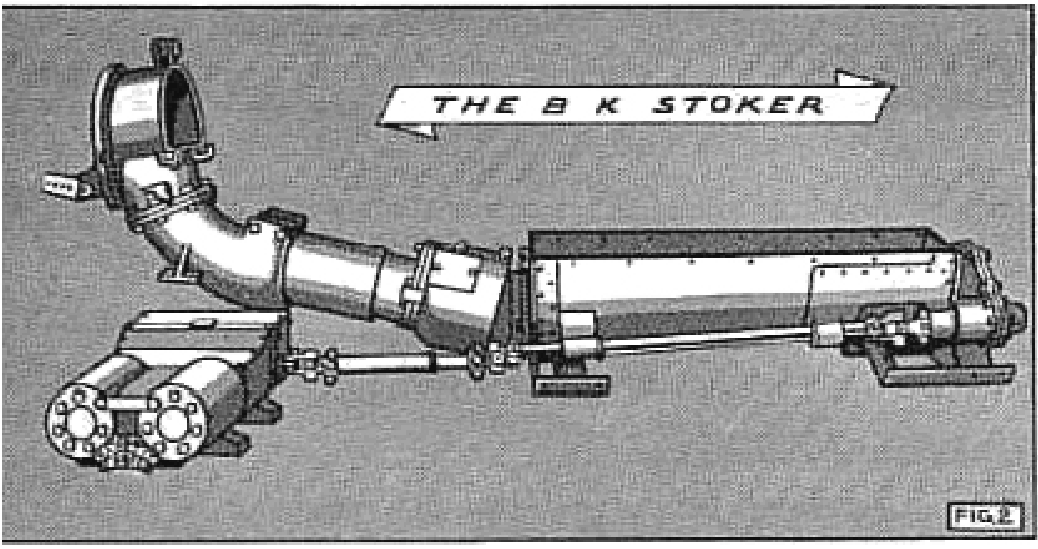


FIG. 2

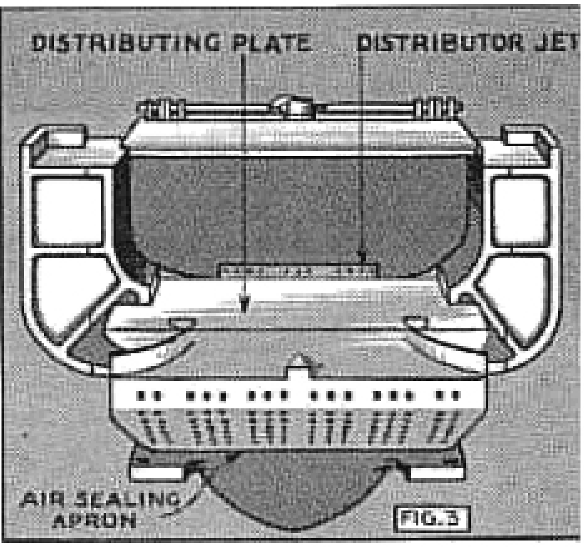


FIG. 3

dle valve has a different effect on the distribution of the coal over the fire. The BK center jet (Fig. 4) is a main distributing jet on the same plane as the other jets, whereas the HT center valve is called a fine-coal jet and is below the main jets. (Refer to Unit P-4 for the function and adjustment of each of the jet valves.)

3. The BK-type stoker uses either the V-type manifold with built-in valves, or the cylinder manifold with either separate valves or built-in valves (Fig. 4). The stoker engine on both the BK and HT stokers may be located either on the locomotive or on the tender.

4. The BK type has no conveyor screw in the discharge or elevator pipe as has the HT stoker.

FEATURES OF THE STANDARD B AND MODIFIED B (MB) STOKERS

The operation of the tender unit, the driving engine, and the jet valves, is the same as that of the HT and BK stokers. The chief difference is in the design of the distributing unit in the firebox. The distributing unit consists of a straight conduit parallel with the door sheet and located in the firebox with

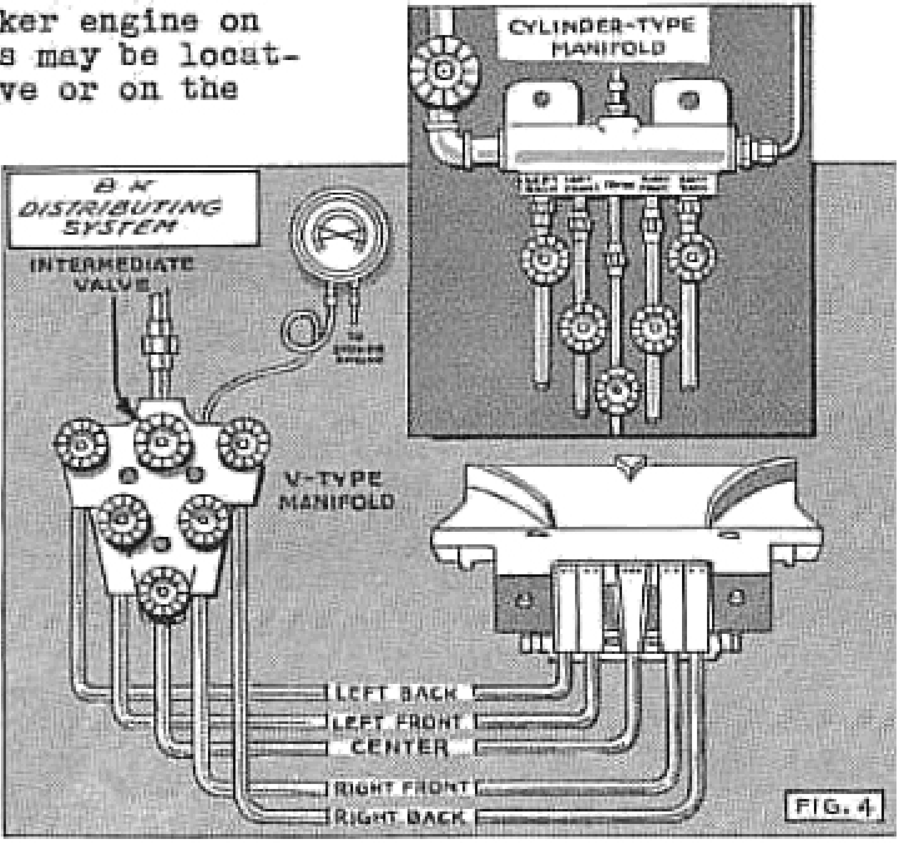


FIG. 4

a protective grate around the conduit (Fig. 5). The conduit does not contain an elevator screw. The coal is distributed by the stoker jets as it is pushed out of the top of the conduit.

Air admitted through the protective grate, cools the distributing unit.

This type of stoker is lubricated the same as the BK and HT.

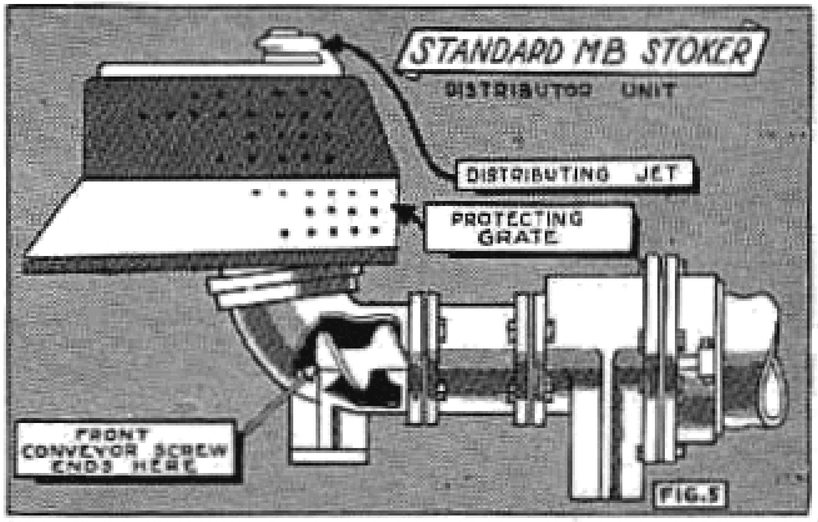


FIG. 5

FEATURES OF THE DUPLEX STOKER

The Duplex Stoker (Fig. 6) has two elevators and two outlets into the firebox. The coal is supplied by the right and left elevator screws to two distributing plates located at the right and left of the fire door and inside of the firebox.

The speed of the stoker is variable and is controlled by the stoker-operating valve (Fig. 6-A) in a manner similar to the method employed on other types of stokers.

A booster valve (Fig. 6-B) is provided so that extra pressure can be used when large lumps of coal are to be crushed.

Each elevator can be operated independently of the other by moving the elevator-pawl shifter (Fig. 6-C). This arrangement facilitates the location and removal of obstructions.

A door in the cab deck is provided so that stoker obstructions can be removed from the transfer hopper.

An adjustable dividing rib is located between the two elevators

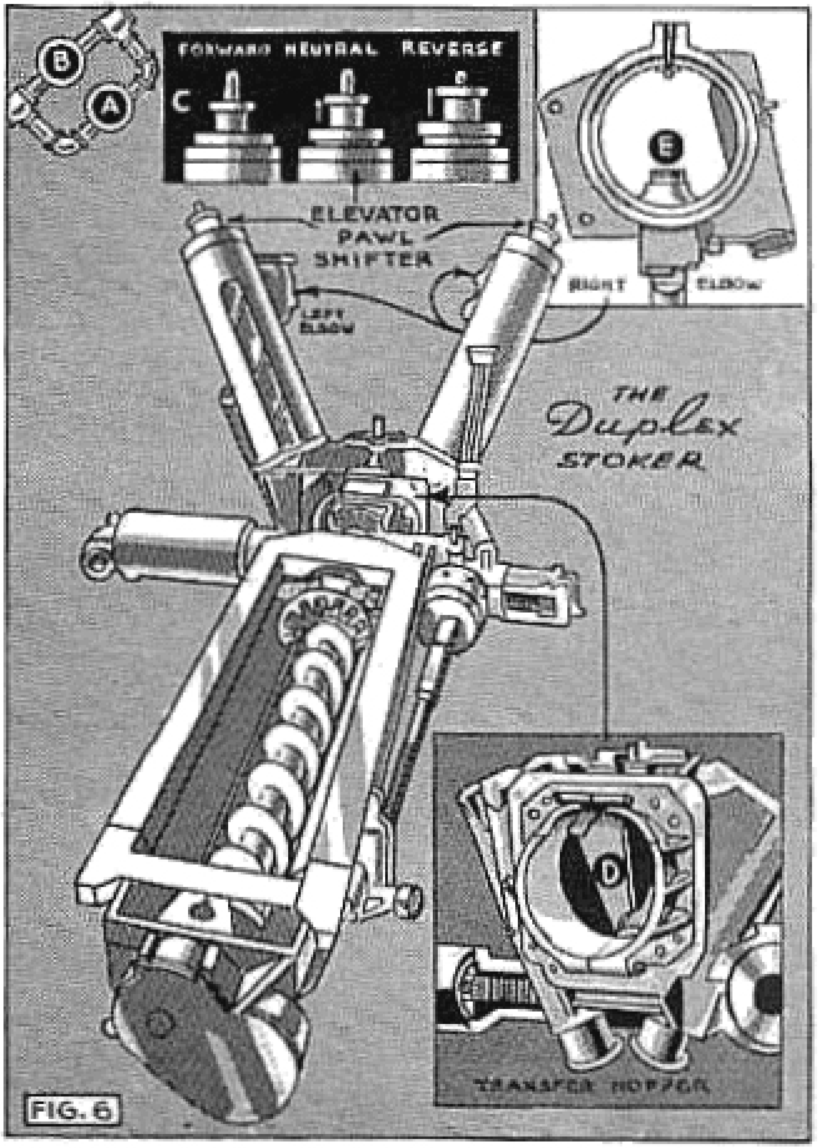


FIG. 6

in the transfer hopper (Fig. 6-D) to control the amount of coal supplied to each elevator.

The distributing system consists of a steam jet located in the back and bottom portion of each distributor elbow (Fig. 6-E). The distributors have deflecting ribs to distribute the coal to the right and left back corners of the firebox and over the whole grate area.

There is an intermediate valve in the steam-jet line so that the jets can be shut off without changing the adjustment of the individual jet valves.

If the tender unit fails, the locomotive can be fired manually. The door in the deck of the cab over the transfer hopper can be raised and coal can be shoveled into the hopper.

FEATURES OF STANDARD LT-1 and LT-2 STOKERS

These two stokers combine the features of the Duplex and the HT stokers and are operated in practically the same way. There is, however, a difference in the construction of certain parts so that they may be adapted to locomotives of different classes.

These stokers combine the driving engine, the conveyor, the reverse mechanism, and the tender unit of the Duplex D-1 and D-2 with the delivery and distributing unit of the HT. The stoker operating controls are the same as those of the Duplex but the coal distributing adjustments are the same as those of the HT.

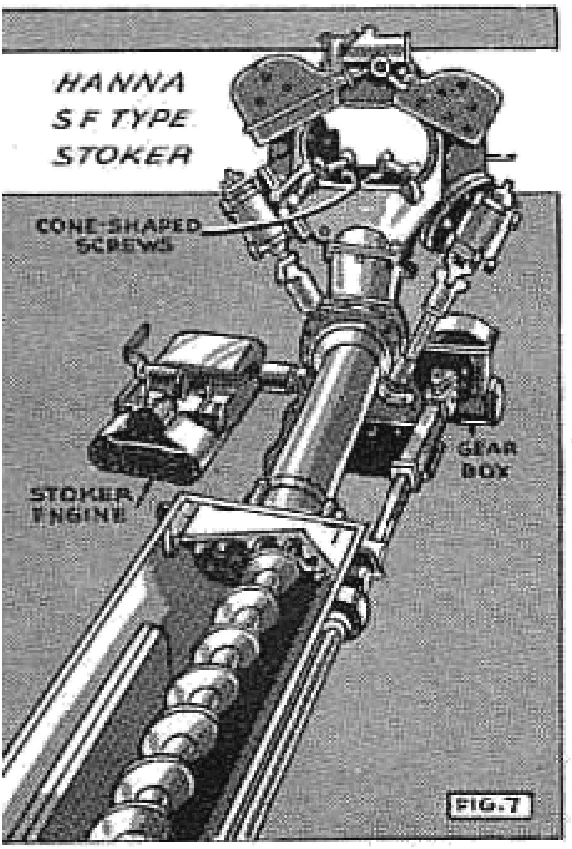


FIG. 7

FEATURES OF THE HANNA STOKERS

The Hanna SF-type stoker (Fig. 7) consists of the usual type of conveyor, crusher, and screws to convey the coal through the conduits to the transfer hopper.

The coal is elevated to a point of delivery by a pair of cone-shaped screws (Fig. 7) within the door housing of the stoker.

Three jet valves are provided: the usual intermediate valve for control of all stoker jets and two other jet valves, a fine-coal jet valve and a coarse-coal jet valve.

The distributor plate is provided with a channel at each side for directing coal to the rear corners of the firebox. Adjustable slides on the SF and adjustable gates on the H-4 are provided at each side of the firing opening so that the right amount of coal can be directed to the back corners.

The Hanna H-4 stoker (Fig. 8) differs from the Hanna SF type in that it does not have the two cone-shaped screws in the fire-door housing. Instead, it has two coal-deflecting gates located in the center of the discharge neck. These gates can be adjusted so that the amount of coal desired can be deflected toward the center of the distributing table. This arrangement makes possible the regulation of the amount of coal supplied to the back corners.

Two jet valves are provided for the distribution of the coal over the fire. One valve controls the fine coal blasts and the other controls the coarse coal or top blasts.

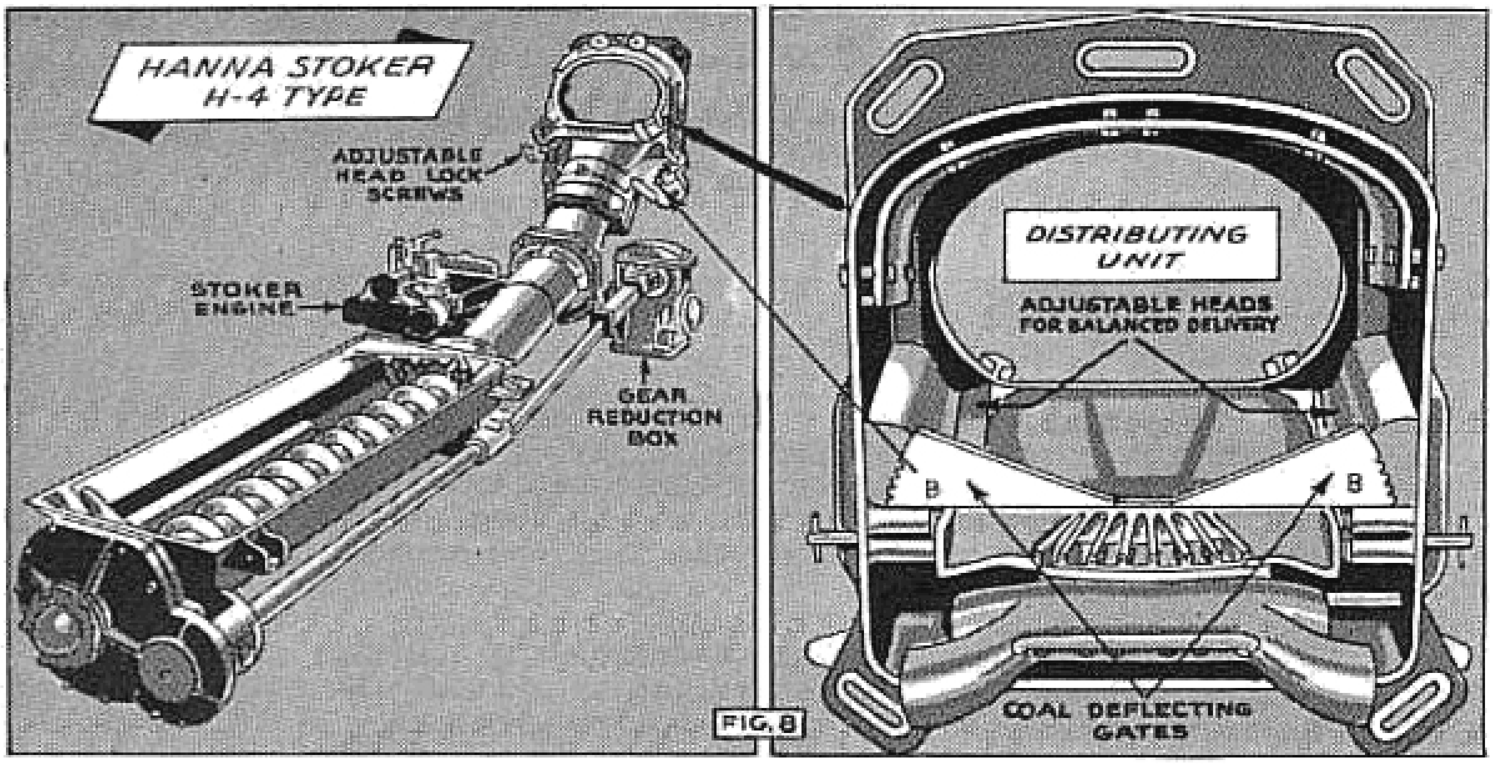


FIG. 8

SELECTED REFERENCES

Examinations for Firemen and Hostlers	New York Central System
Traveling Engineers' Examination Book	Railway Fuel and Traveling Engineers' Association
Locomotive Cyclopedia	Simmons, Boardman Pub. Co.

Instruction Manuals supplied by stoker manufacturers

HOW TO ADJUST STOKER JETS

OBJECTIVES

1. To call attention to the safety precaution involved in stoker-jet adjustment.

2. To explain the function of the stoker jets.

3. To point out the importance of properly regulated jet pressures for different kinds and grades of coal.

4. To point out the direct relation between the jet pressures and the volume of coal delivered to the firebox.

5. To explain how to adjust the jet pressures.

INTRODUCTORY INFORMATION

Most modern coal-burning locomotives are equipped with mechanical stokers. The mechanical stoker has made possible greater sustained tractive effort at a higher rate of speed than could be obtained by hand firing.

Correct stoker speed combined with proper jet pressures is one of the keys to successful stoker firing and will assure an even distribution of coal to the firebox at all times.

The stoker speed and stoker-jet pressures should be regulated to feed a constant, evenly distributed supply of coal into the firebox. The fireman should understand that the amount of coal brought to the firebox is controlled by the stoker speed, and that the distribution of the coal evenly over the fire bed depends upon properly adjusted jet pressures.

The fireman should recognize that overcrowding the fire is a serious fault. Overcrowding can be avoided by running the stoker just fast enough to maintain the correct boiler pressure. The fireman should also understand that jet pressures should be changed as the condition of the coal at the distributing table changes. Lump coal, slack coal, wet coal, and dry coal call for different jet pressures.

EQUIPMENT REQUIRED

The equipment provided should comply with local instructions.

Monkey Wrench
Alligator Wrench
Scoop Shovel
Jet Hook

Wire Torch
Torpedoes
Shaker Bar
Grease Gun

Slide Hook
Fire Rake
Packing Hook
Flags (Red and White)
Packing Spud
Coal Pick
Lanterns (Red and White)
Fusees
Oil Can and Waste
Drinking Water Container

HOW TO ADJUST STOKER JETS

PROCEDURE

1. Inspect the fire to determine its condition before proceeding to adjust stoker jets. Refer to Unit P-2, How to Inspect the Fire.

2. Check the thickness of the fire bed by estimating the distance from the distributing table and smoke-consumer holes (combustion-tube holes) to the top of the fire.

   NOTE: Smoke-consumer holes are approximately 20" from the grates. The fire thickness should be 10" or less (Fig. 1).

3. Observe the grade, size, and condition of the coal because the jet pressures required are determined by the kind of coal to be fired. See Units I-6, P-6, and P-8 for information on coal as fuel and on general firing practices.

4. Start the stoker by opening the stoker-engine throttle valve to admit steam to the stoker engine, and set it to run just fast enough to maintain the desired boiler pressure. Refer to Unit P-3, How to Operate the Stoker.

   NOTE: The stoker-throttle valve should be opened slowly to remove condensation from the line.

5. Turn on the intermediate jet valve slowly (Fig. 2).

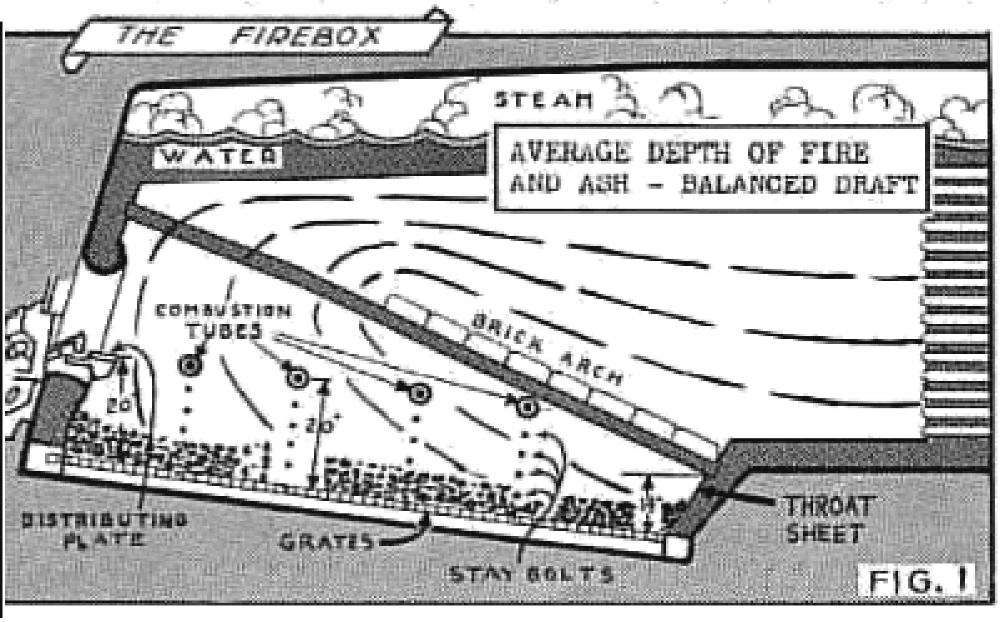


FIG. 1

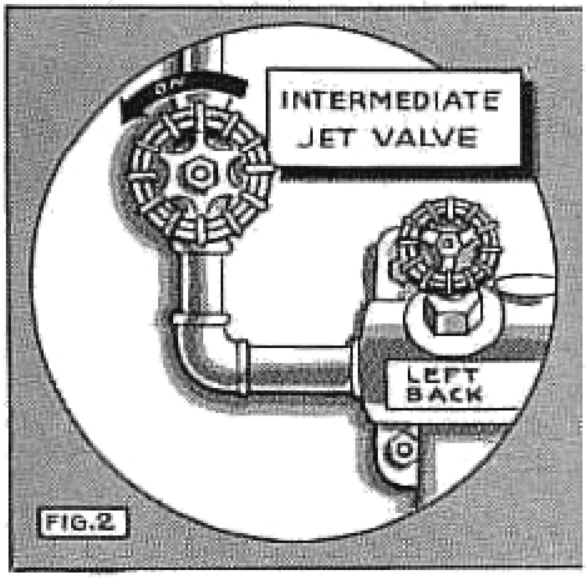


FIG. 2

NOTE: If the intermediate jet valve and the five jet valves are fully opened suddenly, the jet plate may be damaged.

6. Test the stoker jets by opening each of the five jet valves (Fig. 3) separately before the engine leaves the terminal to be sure that they are working properly.

NOTE: Sometimes one or more of the jet openings is plugged. If this is the case, close all of the jet valves except the one controlling the plugged hole. Open this one wide to blow out the obstruction. If this does not remove the obstruction, use a jet hook to open the hole.

7. Observe the grade, size, and condition, as well as the amount of coal being delivered to the distributing table (Fig. 3). Coal delivered to the distributing table may be observed through the peepholes in the top of the elevator pipe.

8. Adjust the upper left-hand valve, marked "Left Back," (Fig. 3). This valve controls the amount of coal supplied to the left back corner.

NOTE: The difficulty of supplying the back corners with adequate fuel often causes these places to be troublesome. Refer to Unit I-8, What Can Happen to a Fire.

9. Adjust the upper right-hand valve, marked "Right Back," (Fig. 3) to distribute the coal to the right back corner which is often likely to be short of coal.

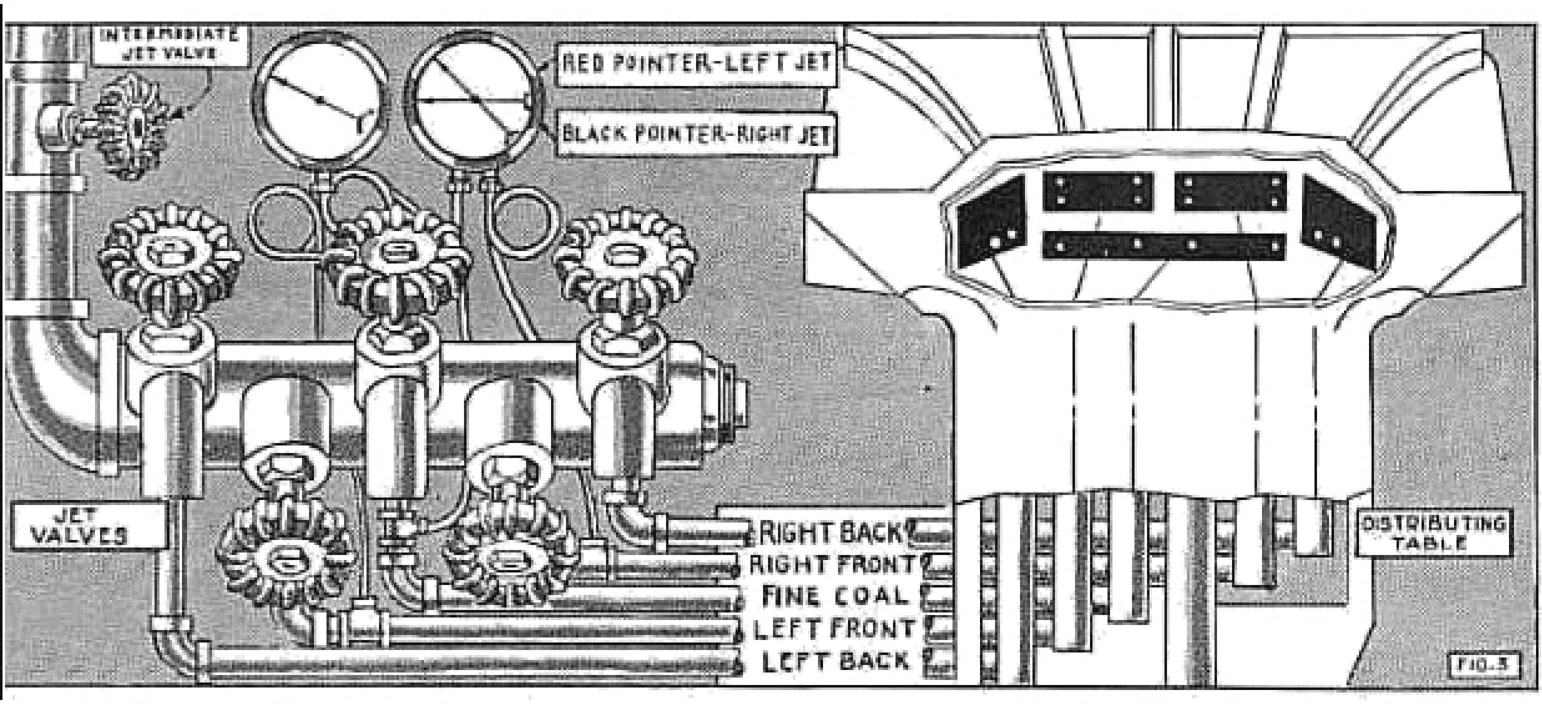


FIG.3

NOTE: A steam-pressure gage is not provided for the right back and the left back jets because only enough steam should be used to remove the coal from the corners of the distributing plate.

10. Adjust the lower left-hand valve, marked "Left Front," (Figs. 3 and 4). Refer to page 40.

NOTE: On the Standard HT Stoker this valve controls the steam to the upper block of four holes on the left front half of the jet plate (Fig. 3). The adjustment of this valve controls the distribution of the coal to the left front and left center of the firebox. The lower right-hand valve performs the same function on the right side of the firebox.

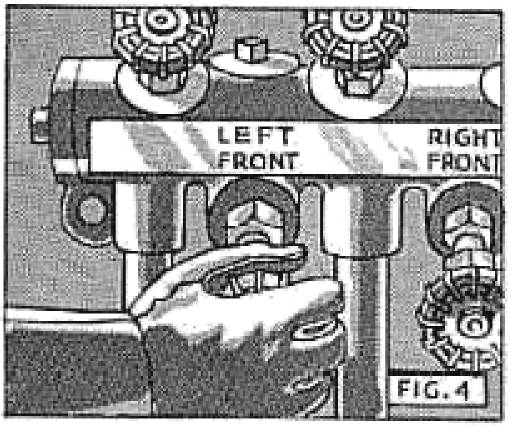


FIG. 4

A duplex steam gage (Fig. 7) with a red hand for the left front and a black hand for the right front section shows the pressure being used on these jets.

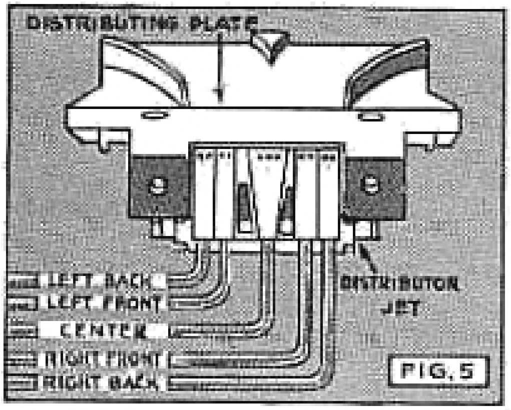


FIG. 5

NOTE: On the Standard BK Stoker this valve controls the steam to the two holes in the left front of the jet plate (Fig. 5). The adjustment of this valve distributes the coal to the left front and left side of the firebox. The lower right-hand valve performs the same functions on the right side of the firebox.

On the BK Stoker one steam gage connected to the jet manifold indicates the steam pressure on all of the jets. A duplex gage may be used as a combination stoker-engine gage and jet-manifold gage. (See page 40.

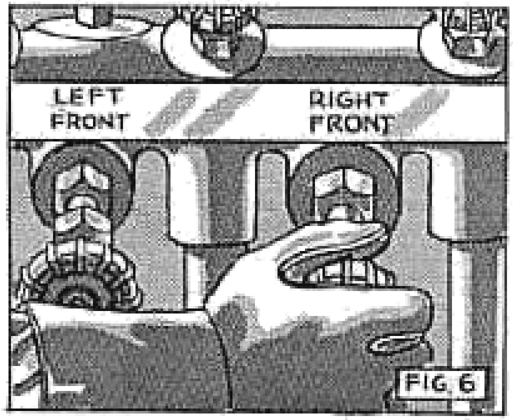


FIG. 6

11. Adjust the lower right-hand valve, "Right Front," (Figs. 3 and 6).

12. Adjust the center valve.

NOTE: On the HT stoker this valve is called the fine-coal valve and distributes the fine coal over the entire firebox. It controls the steam to four holes located below the front corner jets

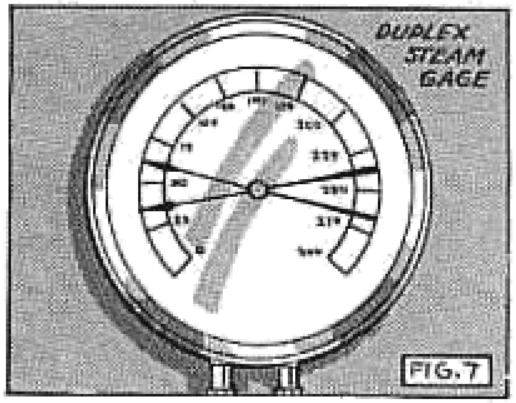


FIG. 7

(Fig. 3). This valve blows steam between the ribs of the distributing table to distribute the fine coal which falls between the ribs. A separate gage (Fig. 3) is provided for this jet.

NOTE: On the BK stoker the center valve controls the distribution of coal over the front and center of the firebox through the three holes in the center of the distributor plate (Fig. 5).

13. Inspect the fire frequently, especially after adjusting the jet pressures, to make certain that the coal is being distributed evenly to all parts of the firebox and that the fire has a uniform depth. (See Unit P-2 for detailed information on How to Inspect Fires.

14. Observe the pressure indicated on the jet gage or gages to facilitate resetting after the stoker has been shut off.

NOTE: A change in the size or condition of the coal may necessitate a change in jet pressures.

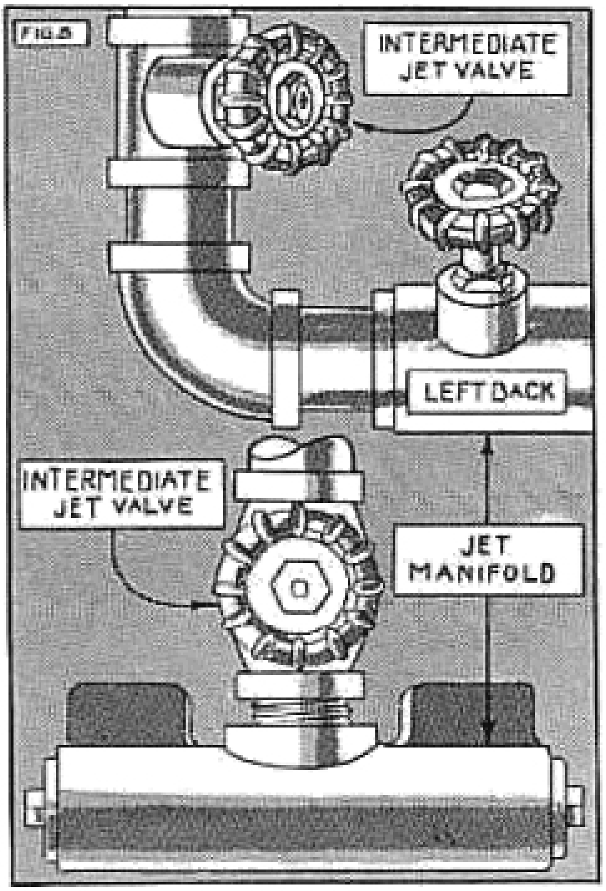


FIG.8

15. Observe the reading on the boiler-pressure gage as any changes in boiler pressure should be compensated for by adjusting the intermediate jet valve to maintain an even distribution of coal in the firebox. Fig. 8 shows two different installations of the intermediate jet valve.

16. On arrival at the engine terminal, place the stoker-operating lever in neutral position, and close the stoker-engine throttle valve and the jet valves. (See page 38 for procedure at the terminal.)

NOTE: If the intermediate jet valve (Fig. 8) is not provided with a bleed hole, the valve should be left slightly open or "cracked" until the fire is dumped. This precaution will prevent overheating of the distributing table.

THE DUPLEX STOKER

On the Duplex Stoker (Fig. 9) the same general distribution procedure will apply, except that only two jet valves are provided:

one to control the coal delivered by the right elevator, and one to control the coal delivered by the left elevator.

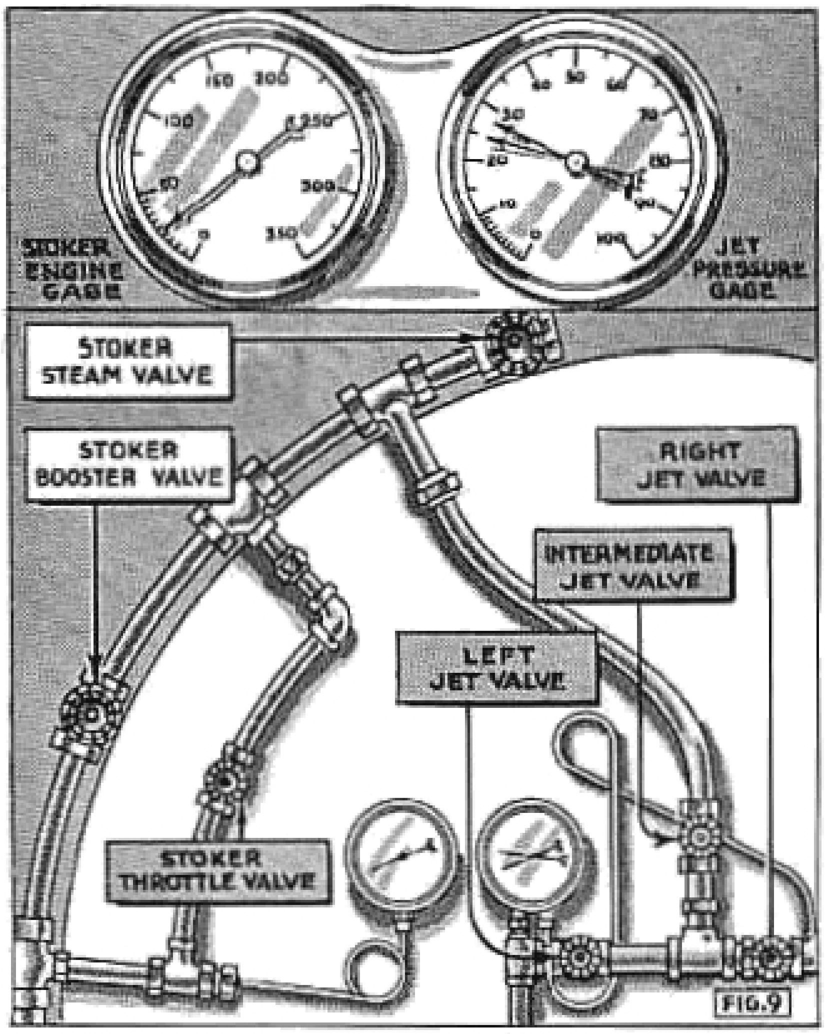


FIG.9

1. Open the main valve on the steam turret.

2. Open the stoker steam valve to admit steam to the stoker engine and jet lines.

3. Open the intermediate jet valve to admit steam to the distributor jet lines.

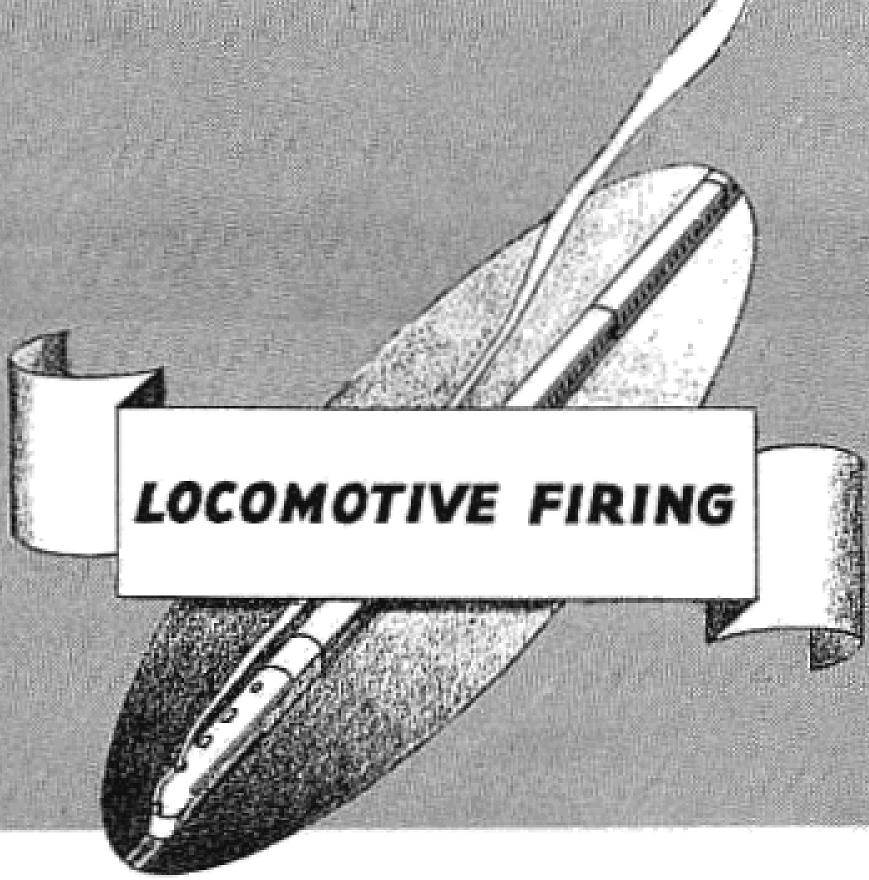
4. Adjust the right and left jets to distribute the coal evenly over the fire bed.

5. Observe the pressure on the jet-pressure gage. The two hands are marked to assist in adjusting the jets.

6. Inspect the fire frequently to make certain that coal is being evenly distributed over the fire bed.

NOTE: Decreasing the jet pressures will build up the fire in the back of the firebox. Increasing the jet pressures will build up the fire in the front of the firebox.

Equal distribution of the coal to the sides of the firebox is controlled by the dividing rib in the transfer hopper.



LOCOMOTIVE WATER SYSTEMS

UNIT I-5
Pages 52-59

UNIT P-5
Pages 60-68

UNIVERSITY OF THE STATE OF NEW YORK
STATE EDUCATION DEPARTMENT
BUREAU of INDUSTRIAL AND
TECHNICAL EDUCATION

LOCOMOTIVE WATER SYSTEMS

OBJECTIVES

1. To explain the general operation of the locomotive water system.
2. To explain the use of feed-water pumps.
3. To explain the use of the injector.
4. To explain the use of the water glasses and the gage cocks.

INTRODUCTORY INFORMATION

The efficiency of the locomotive boiler is gaged in terms of how much water can be evaporated, or converted, into steam per pound of coal burned. Every square foot of grate surface in the firebox must be used to full capacity when the locomotive is pulling a load. Full efficiency of the boiler can be obtained only when the locomotive is properly fired and the feed-water system is properly operated.

Good, even pumping of the boiler is a technique which each fireman should attempt to acquire. Considerable coal can be wasted and the efficiency of the boiler impaired if the fireman does not have a thorough knowledge of how the water system of the locomotive operates.

The injector, which is operated by the engineman, is used to supply water to the boiler while the locomotive is drifting or idle. The pump, which is operated by the fireman, is used while the locomotive is working.

Water can be taken into the tender without the necessity of stopping, by means of a water scoop which is dropped by the fireman into the track pan. From the tender the water is pumped into a feed-water heater where it is heated by exhaust steam before it is fed through the boiler check valve into the boiler.

Two kinds of feed-water heaters are in common use. These may be classified as the open type and the closed type, as described in this unit.

DESCRIPTION OF WATER-LEVEL INDICATING DEVICES

BOILER WATER-LEVEL GAGES

From the viewpoint of safety and efficient operation, the devices on the back head of the boiler (Fig. 1) for maintaining the water in the boiler at the correct level, are among the most important devices on the locomotive.

The water-level indicating devices include a water column, one water glass on the water column, one water glass on the boiler, gage cocks, and a low-water alarm. These are for the purpose of giving an indication of the height of the water under all conditions of service so that the fireman and the engineman will know that there is sufficient water above the crown sheet (Fig. 1) for efficient operation and, especially, for safety.

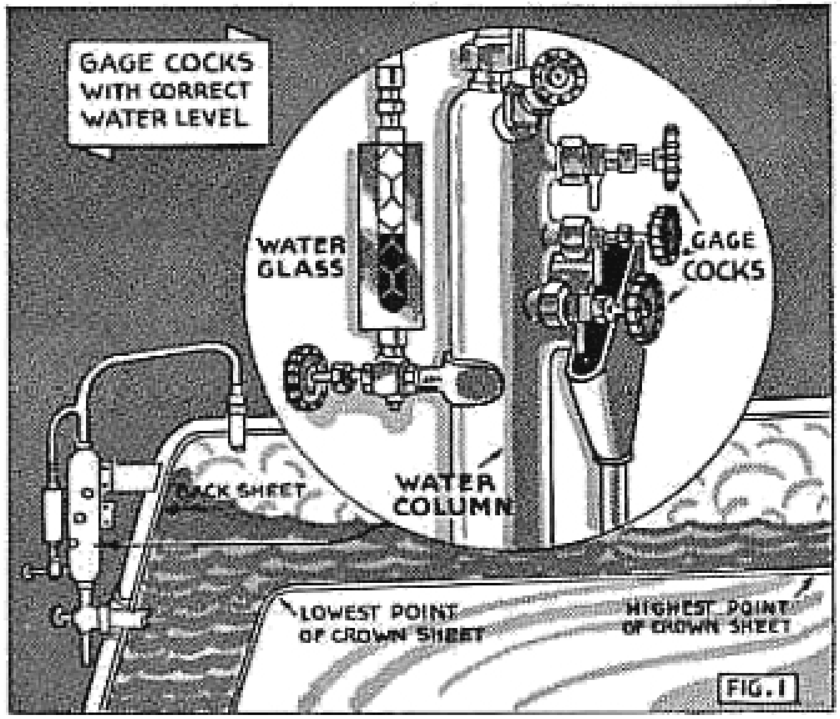

GAGE COCKS WITH CORRECT WATER LEVEL
WATER GLASS
GAGE COCKS
BACK SHEET
WATER COLUMN
LOWEST POINT OF CROWN SHEET
HIGHEST POINT OF CROWN SHEET

FIG. 1

The gage cocks (Fig. 1) and the two water glasses are devices provided for checking the water level in the boiler. The two water glasses provide a double check by the fireman and by the engineman. The gage cocks are used to check the water glass readings and should be used frequently.

The water column (Fig. 1) is attached to the back sheet, and the gage cocks and one water glass are mounted on it. This arrangement gives a much more accurate indication of the water level in the boiler than can be had when the gages are mounted directly on the back sheet because the water has a tendency to pile up on the back sheet as shown in Fig. 1. This tendency to "pile up" is caused by the rapid circulation of the water through the arch tubes and around the firebox when the locomotive is working.

The correct water level is two gages of water, or even with the middle gage cock which is midway between the upper and lower gage cocks (Fig. 1). The correct water level is indicated by the following tests:

1. A full stream of water when the bottom gage cock is opened.
2. A flutter of steam and water when the middle gage cock is opened.
3. Steam discharged from the upper gage cock.

Before the locomotive leaves the terminal, the water column and water glasses should be blown out as directed in Unit P-5, How to Pump the Boiler.

Water-glass connections may gradually become clogged. This is indicated by slow or sluggish up-and-down movement of the water in the glass or by the failure of the water-glass level to register with the gage cocks.

A shield is installed around the water glass as a protection against injury from steam and broken glass in case the water glass breaks.

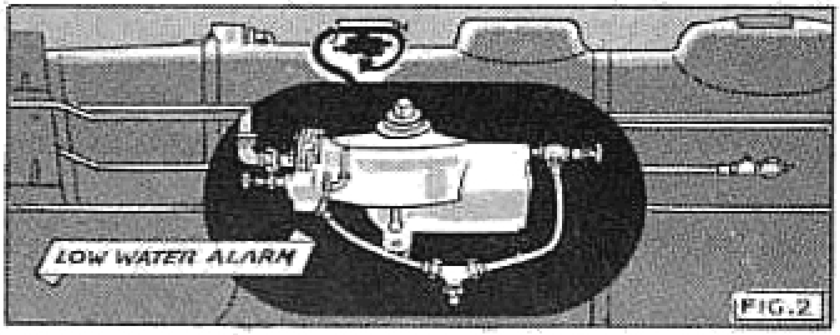


FIG.2

The low-water alarm (Fig. 2) is a device installed on the top of the boiler ahead of the cab. It will blow when less than one inch of water shows on the water glass.

CAUTION: When the low-water alarm sounds, open the lower gage cock (Fig. 1). If water does not run out, the fire must be dumped immediately. If the bottom gage cock shows that there is water in the boiler, increase the water supply and raise the water in the boiler to the proper level.

LIVE STEAM INJECTORS

The injector is operated by the engineman to supply water to the boiler when the locomotive is drifting or standing, and also when starting out, before the feed-water heater has reached normal temperature.

The injector operates on the principle of imparting to cold water the velocity of steam. The flow of water having been started through the injector to start it, opening the steam valve causes the jet of steam to impinge on and combine with the water, imparting sufficient velocity to the water to force it through the delivery pipe, opening the boiler check valve, and injecting the water into the boiler.

There are two types of injectors in use, the lifting and the non-lifting injectors. The lifting type of injector raises the water and forces it into the boiler. This injector is located just above the highest level of water in the supply tank. The non-lifting injector cannot raise the water, and therefore must be located below the lowest water level of the tank so that the water will flow from the tank to the injector by gravity.

EXHAUST STEAM INJECTORS

The exhaust-steam injector imparts velocity to the water by using low-pressure exhaust steam supplemented by a small amount of high-pressure steam called supplementary steam. The low-pressure steam is obtained from the exhaust of the locomotive; when no exhaust is available, it is replaced by boiler steam called auxiliary steam.

A gage is provided to show the working pressure of the injector. The injector-pressure gage (Fig. 3) has two hands and a pointer. The black hand shows exhaust pressure in the injector body when the injector is working on exhaust steam and also shows auxiliary pressure at the same point when the device is working as a live steam injector. The red hand shows the overflow pressure in the injector. The brass pointer is set at the overflow pressure, and, when this point is reached by the red hand, the engineman knows that water is spilling at the overflow and that the amount of water being injected into the boiler should be reduced by the water-regulator handle.

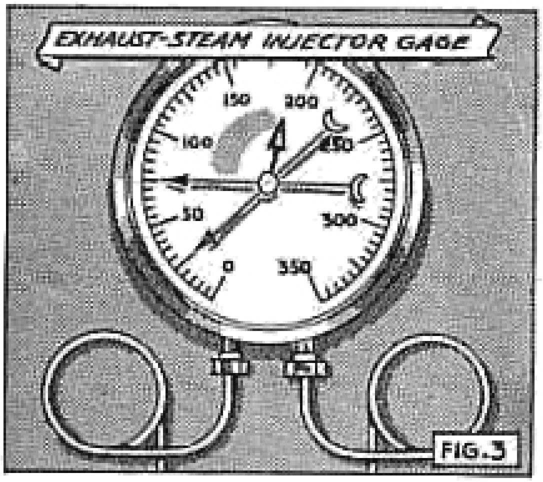


FIG.3

FEED WATER PUMPS

Locomotives are equipped either with two injectors or with one injector and a water pump. The feed-water pump saves fuel because it uses exhaust steam instead of live steam to heat the water before it is forced into the boiler. Water pumps (Fig. 4) are used to maintain the correct level of water in the boiler except when the locomotive is drifting, standing, or starting out, at which time the injector is used.

The injector is used at these times owing to the lack of exhaust

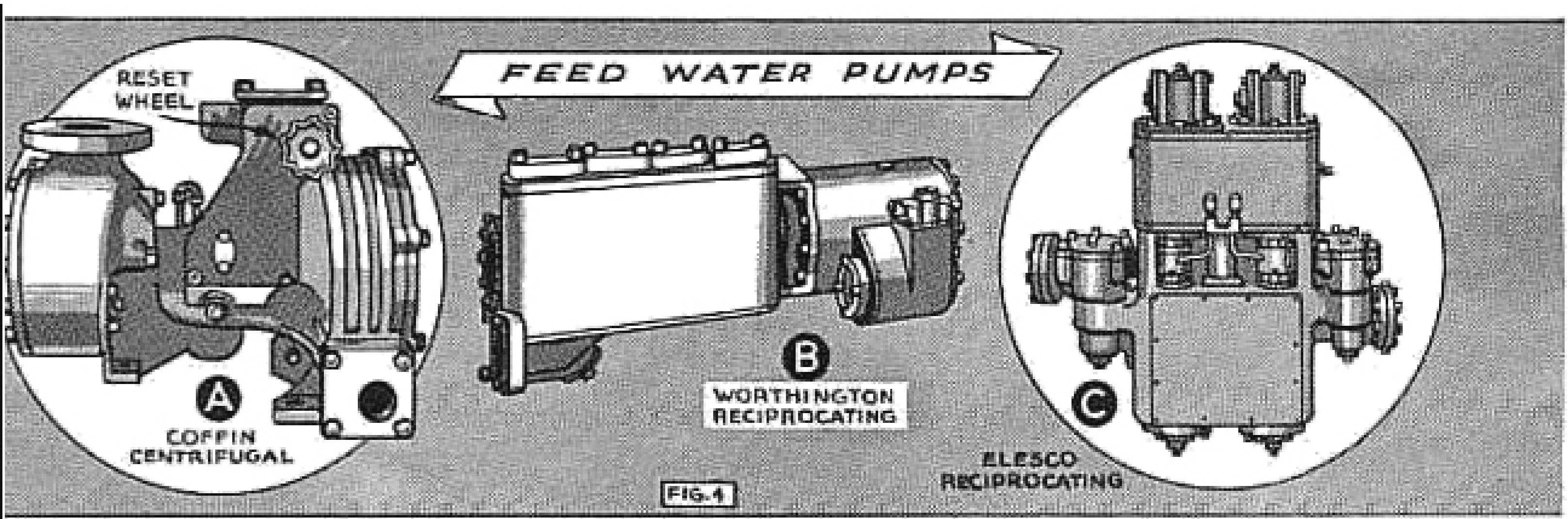


FIG.4

steam. Without the injector it would be necessary to pump cold water into the boiler, causing severe strains to be set up. The injector should be used at the start of a trip for the first four or five miles (about seven minutes) to allow the feed-water heater to become thoroughly heated.

The makes of feed-water pumps in common use on locomotives are the Elesco, the Coffin, and the Worthington. Pumps are of two types, centrifugal or rotating impeller type (Fig. 4-A) and reciprocating or piston type (Fig. 4-B and C).

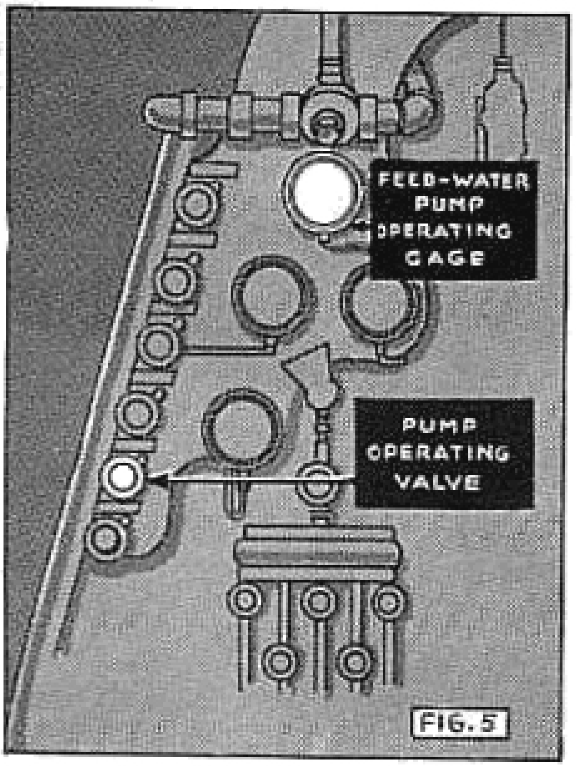


FIG. 5

The fireman controls the amount of water being fed into the boiler by adjusting the pump-throttle valve (Fig. 5) to increase or decrease the speed of the pump. A pump-operating gage (Fig. 5) is located in the cab. This gage shows the fireman when water is being fed into the boiler. When a reciprocating water pump is used, the pulsations (or swinging movement of the hand on the gage) give an indication of the speed of the pump. The speed should be regulated so that the correct water level in the boiler is maintained by pumping at an even speed rather than by intermittently pumping fast and slow.

The speed of the pump should be adjusted so that it is not necessary to shut the pump off. When the locomotive is standing or drifting with closed throttle, the pump should be idled at a speed low enough so that it does not continue to supply the boiler or operate the automatic blowdown.

DESCRIPTION OF FEED-WATER HEATERS

When the water is drawn from the tender tank by the feed-water pump, it is passed through a feed-water heater located in front of the smoke stack (Fig. 6) The advantages of heating the water before it is delivered to the boiler are readily apparent: the steaming qualities of the boiler are improved, power of the locomotive is increased, and fuel is saved. Feed-water heaters are of two kinds, the open type and the closed type.

The closed type of heater (Fig. 6) heats the water by passing it through a number of copper tubes surrounded by exhaust steam. The water does not come into direct contact with the steam. Exhaust steam flows past the tubes in a direction counter to that of the water flow so that the hottest water is surrounded by the hottest steam.

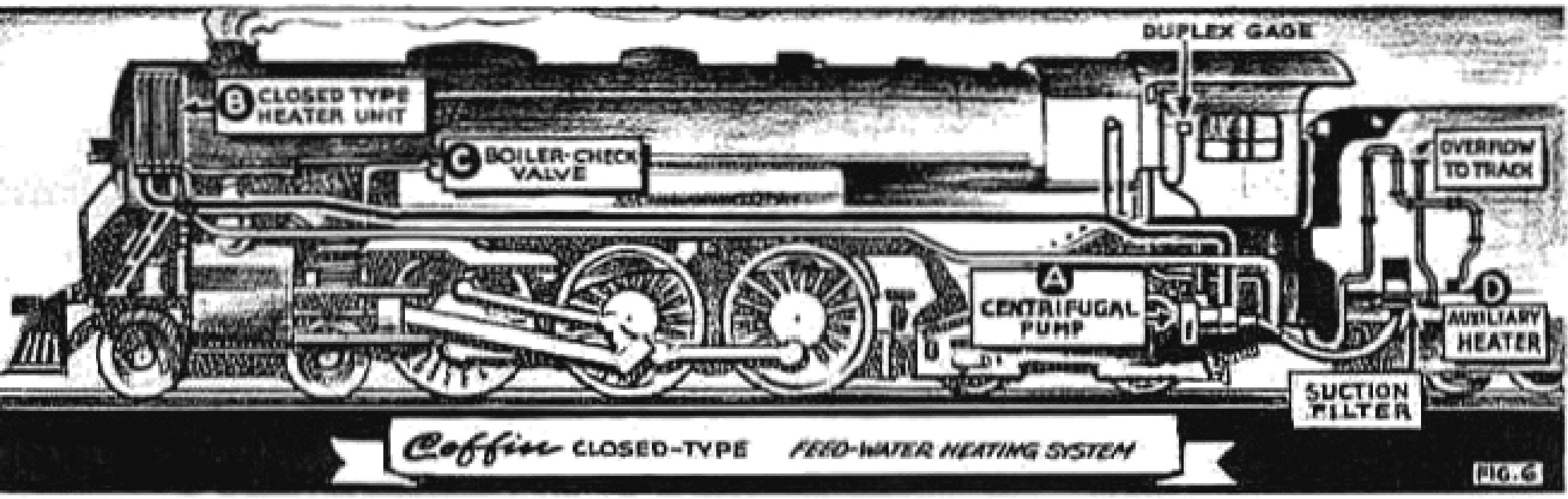


FIG. 6

The open type of heater heats the water by injecting exhaust steam directly into the water in a heating chamber (Fig. 8). In this heater the steam is brought into direct contact with the water.

THE COFFIN CLOSED-TYPE FEED-WATER HEATING SYSTEM

In the Coffin Feed-Water Heater System the cold water is taken from the tender tank through a filter in the suction pipe to the centrifugal-type cold-water pump (Fig. 6-A). From the cold-water pump, the water is pumped to the closed-type feed-water heater (Fig. 6-B) located in front of the stack.

From the heater the water is forced by the pump through the boiler check valve (Fig. 6-C) into the boiler. The condensate from the heater returns to the auxiliary open-type heater (Fig. 6-D) located in the tender where it partially preheats the feed water by direct contact before it leaves the tender to enter the water pump.

A duplex gage (Fig. 7) located in the cab registers the operation of the centrifugal pump. The gage has two hands, one red and one black. The red hand indicates the pressure of the steam being supplied to the pump. The black hand indicates the pressure of water in the pump discharge line between the pump (Fig. 6-A) and the boiler check valve (Fig. 6-C). This pressure must exceed boiler pressure before water will enter the boiler.

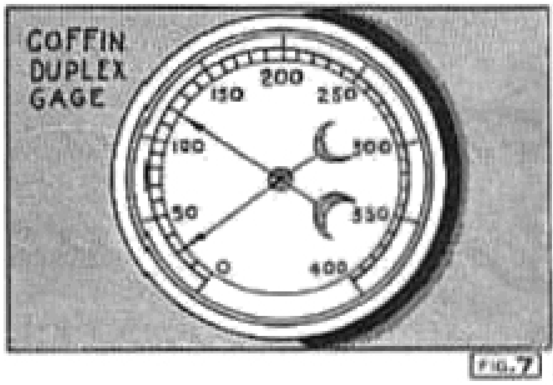


FIG. 7

THE WORTHINGTON OPEN TYPE FEED WATER HEATING SYSTEM

The Worthington Feed-Water Heater System (Fig. 8) takes cold water from the tender through a suction pipe by means of a centrifu-

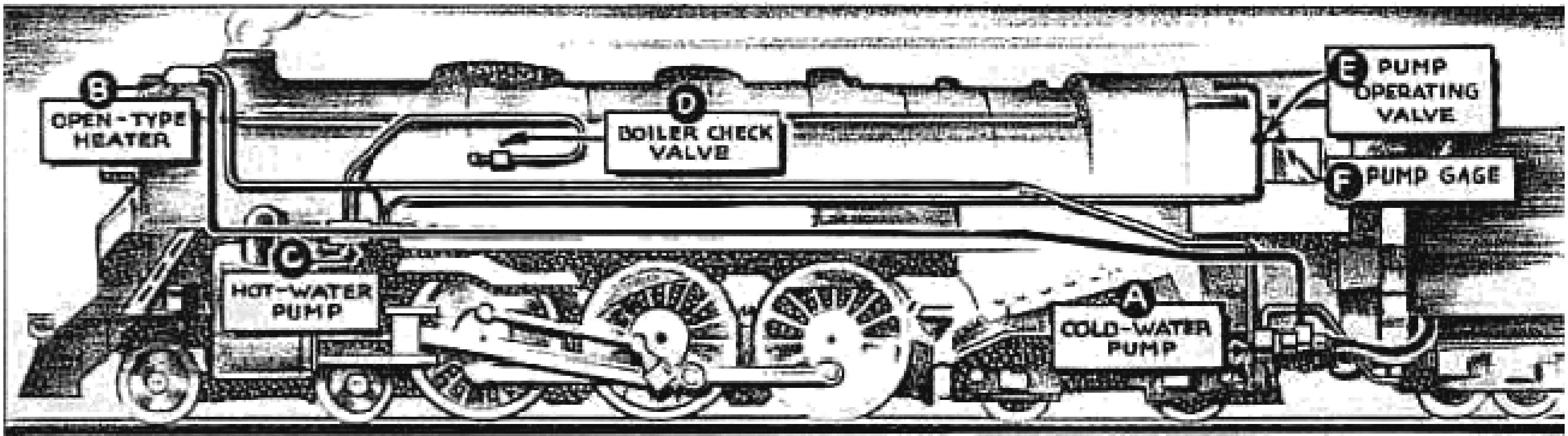


FIG. 8 **Worthington** OPEN-TYPE *FEED-WATER HEATING SYSTEM*

gal cold-water pump (Fig. 8-A) which pumps it into an open-type heater located in front of the smoke stack (Fig. 8-B). Exhaust steam from the locomotive passes into the heater where it comes into direct contact with the water and raises its temperature close to the temperature at which exhaust steam condenses, depending on its pressure. The heated water passes to a horizontal reciprocating hot-water pump (Fig. 8-C) which forces it into the boiler through the boiler check valve (Fig. 8-D).

The amount of water delivered to the boiler by the hot-water pump is controlled in the cab by an operating valve (Fig. 8-E) which regulates the speed of the pump.

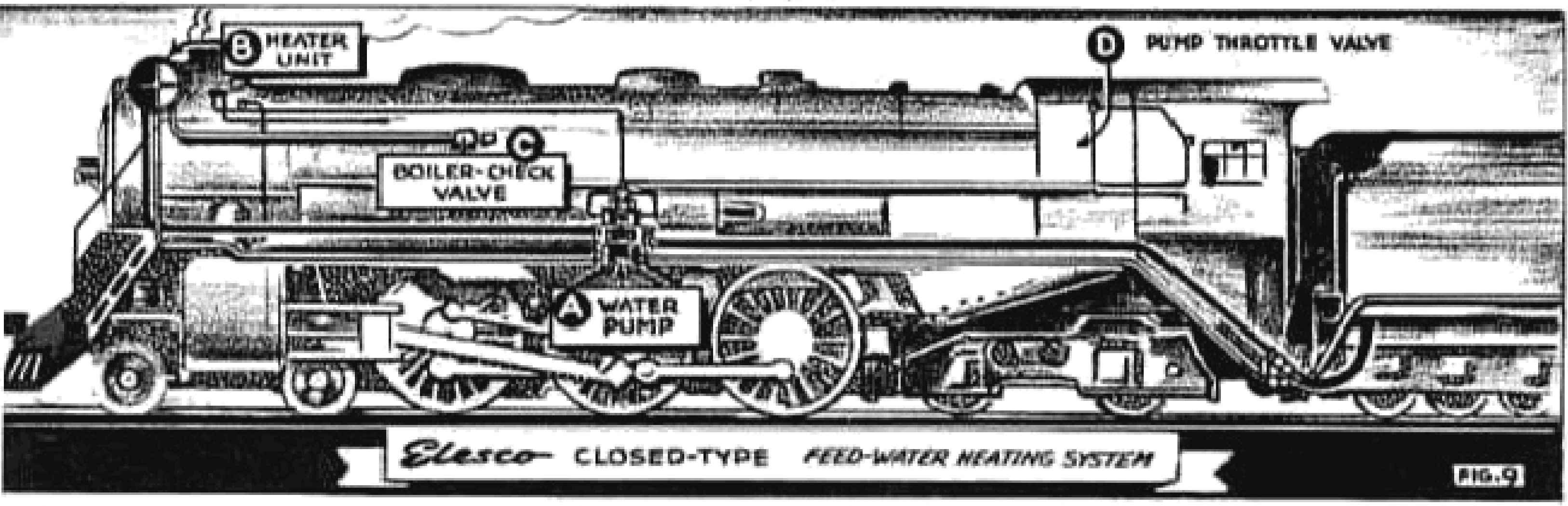
The cold-water pump is automatically controlled by a float-actuated control valve in the heater which regulates the steam to the pump according to the water in the heater. Thus, cold water is pumped into the heater by the cold-water pump as fast as it is taken from the heater by the hot-water pump.

A pump-operating gage (Fig. 8-F) is provided in the cab and is connected to the cold-water line between the pump and the heater to indicate when the cold-water pump is operating.

THE ELESCO CLOSED-TYPE FEED-WATER HEATING SYSTEM

The Elesco Feed-Water Heating System (Fig. 9) uses one pump (Fig. 9-A), which is either a reciprocating or a centrifugal type, to take the water from the tender and force it through the heater (Fig. 9-B) and then through the boiler check valve (Fig. 9-C) into the boiler. The water is heated in a closed-type heater located in the front of the smokebox. The heater is connected into the feed-water system between the pump and the boiler check valve.

The amount of water delivered to the boiler is controlled in the



Elesco CLOSED-TYPE FEED-WATER HEATING SYSTEM

FIG. 9

cab by the pump-throttle valve (Fig. 9-D).

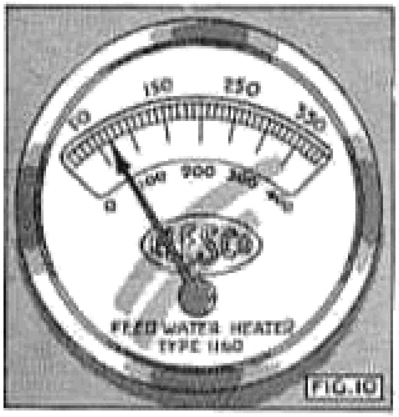


FIG. 10

A gage (Fig. 10) is provided in the cab to indicate the pressure of water in the discharge line from the pump. When the pressure on the gage is less than boiler pressure,the fireman knows that no water is being delivered into the boiler. The fireman soon learns how much higher than boiler pressure the gage must read in order to maintain the correct water level in the boiler under all operating conditions.

EVEN PUMPING

Regardless of the kind of feed-water system in use on a locomotive, EVEN PUMPING should be the goal of every fireman. Water should be pumped at an even speed, just fast enough to maintain the proper level in the boiler at all times. Pumping too fast and then slowing the pump down part of the time should be avoided.

SELECTED REFERENCES

Examinations for Firemen and Hostlers	New York Central System
Instructions for the Preparation and Maintenance of Locomotive Fires	New York Central System
Traveling Engineers' Examination Book	Railway Fuel and Traveling Engineers' Association
Locomotive Cyclopedia	Simmons, Boardman Pub. Co.

Manuals prepared by Manufacturers of Feed-Water Equipment

How to **PUMP** *the* **BOILER** *and* **SCOOP WATER**

OBJECTIVES

1. To stress the importance of maintaining the correct amount of water in the boiler from the standpoint of safety.

2. To emphasize the importance of maintaining the correct amount of water in the boiler from the standpoint of efficiency.

3. To explain the correct way of pumping the boiler.

4. To explain how to use the water gages and how to interpret gage indications.

5. To explain how to scoop water.

INTRODUCTORY INFORMATION

The fireman should be thoroughly familiar with the story which the water gages tell and he should know when to add water and how to add it. The correct amount of water should be maintained in the boiler at all times from the standpoint of safety and of boiler efficiency.

The fireman should recognize the fact that even pumping of the boiler is essential to good firing. Even pumping means operating the pump steadily at a speed just fast enough to keep the water in the boiler at the proper level. Intermittent fast and slow pumping is called saw-tooth pumping.

The locomotive boiler is equipped with a water column, three water-gage cocks, two water glasses, and a low-water alarm located on the boiler ahead of the cab. One water glass is mounted on the water column and one is mounted directly on the boiler back head. These devices (Fig. 1) give the engine crew ample protection against an incorrect water level in the boiler if they are tested and used according to instructions.

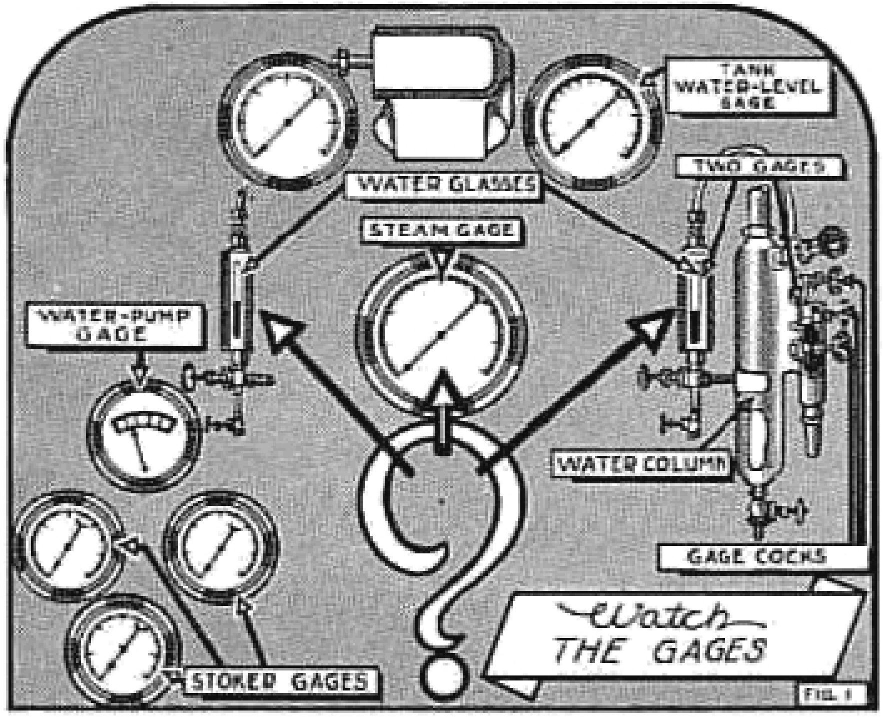


FIG. 1

Running with an insufficient amount of water is a dangerous practice; on the other hand, overpumping will cause the locomotive to "work water," which means that water will be carried into the cylinders with the steam. This destroys the lubrication of the steam cylinder parts and also causes an extra draft through the fire bed which may tear holes in the fire.

EQUIPMENT REQUIRED

Standard equipment as specified by local instructions

PROCEDURE

CARE OF THE WATER SYSTEM BEFORE LEAVING THE TERMINAL

TESTING THE WATER GLASSES AND GAGE COCKS

1. Check the steam pressure by reading the steam gage (Fig. 1). The steam gage should show within fifty pounds of the maximum pressure indicated on the badge plate when the locomotive is taken over by the crew.

2. Check the level of the water in the boiler by observing the water glasses and trying the gage cocks (Figs. 1 and 2). These should indicate two gages of water and should be tested as follows:

    a. Open the lower gage cock — a full stream of water should flow.

    b. Open the middle gage cock — a flutter of steam and water should be discharged.

    c. Open the upper gage cock — steam should be discharged.

    d. Observe both water glasses — they should show half a glass.

    The gage cocks should be used frequently to check the water level indicated by the water glass.

    NOTE: Blow out the gage cocks while checking the water level. Every possible attention must be given to keep the water-glass valves, the gage cocks, and the water column open and in good working order.

    The two water glasses must be blown out when the crew takes charge of the locomotive.

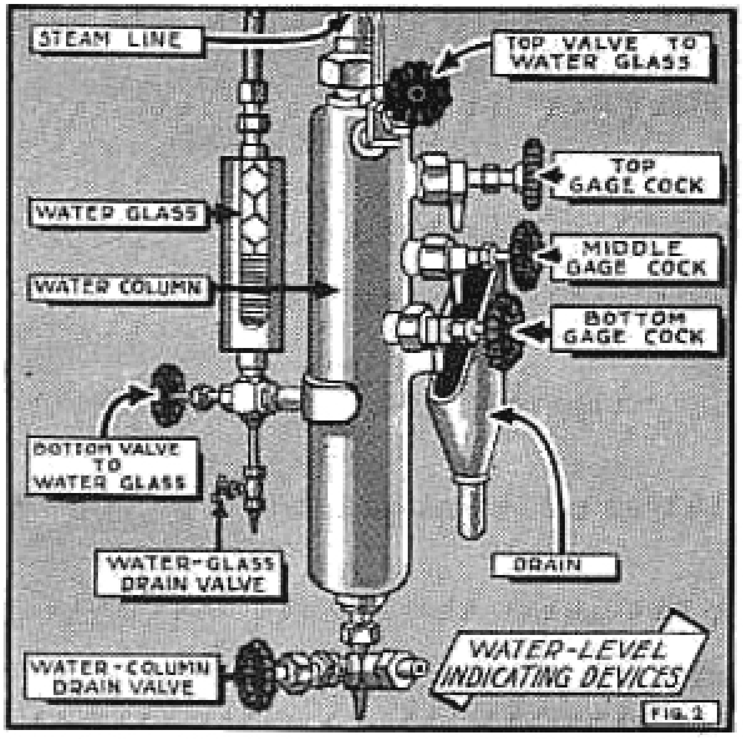
3. Blow out the water column and water glasses (Fig. 2) by the following procedure:

a. Blow out the water column by opening the drain valve wide (Fig. 2) until the water and sediment have been blown out of the column. Then close the drain valve. It is important that this be done first to prevent the sediment from entering the water glass.

b. Blow out the water glass on the column by closing the water valve (Fig. 2) and opening the drain valve (Fig. 2). See that there is a good flow of steam from the drain pipe.

c. Close the steam valve (Fig. 2) and see that both this valve and the water valve are tight.

d. Open the water valve wide and see that there is a good flow of water from the drain pipe (Fig. 2); allow both the drain valve and the water valve to remain open.



WATER-LEVEL INDICATING DEVICES

FIG. 2

e. Open the steam valve (Fig. 2) slowly until it is wide open.

f. Close the drain valve slowly (Fig. 2) and note that both water glasses indicate the same level of water as do the gage cocks.

g. Blow out the second water glass in the same way except that the steam valve is on the turret. The glass is mounted on the boiler, and there is no water column to drain.

h. Make certain that the drain valves are closed tightly.

i. Make certain that the steam valves and water valves to both water glasses are both wide open.

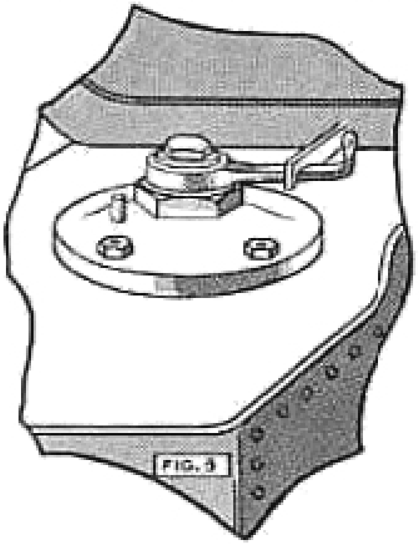


FIG. 3

TESTING THE FEED-WATER PUMP

1. Check the tank valve on the left side of the tender (Fig. 3) to see that it is wide open.
2. Open wide the main valve on the turret Fig. 4.
3. See that the pump boiler check valve (Fig. 5) is wide open.
4. Open the pump-operating valve slowly, and

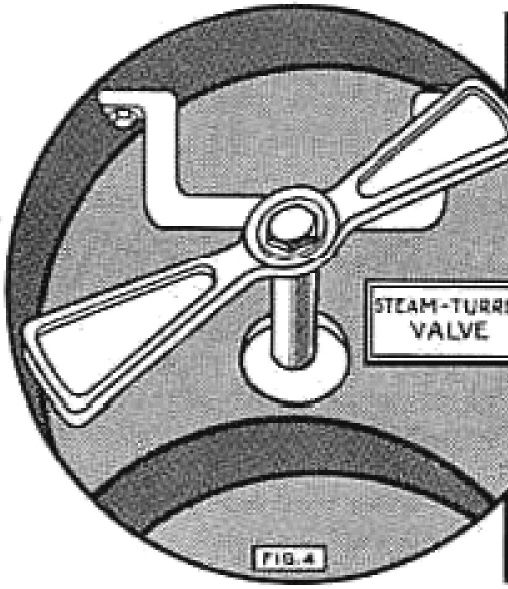


FIG.4

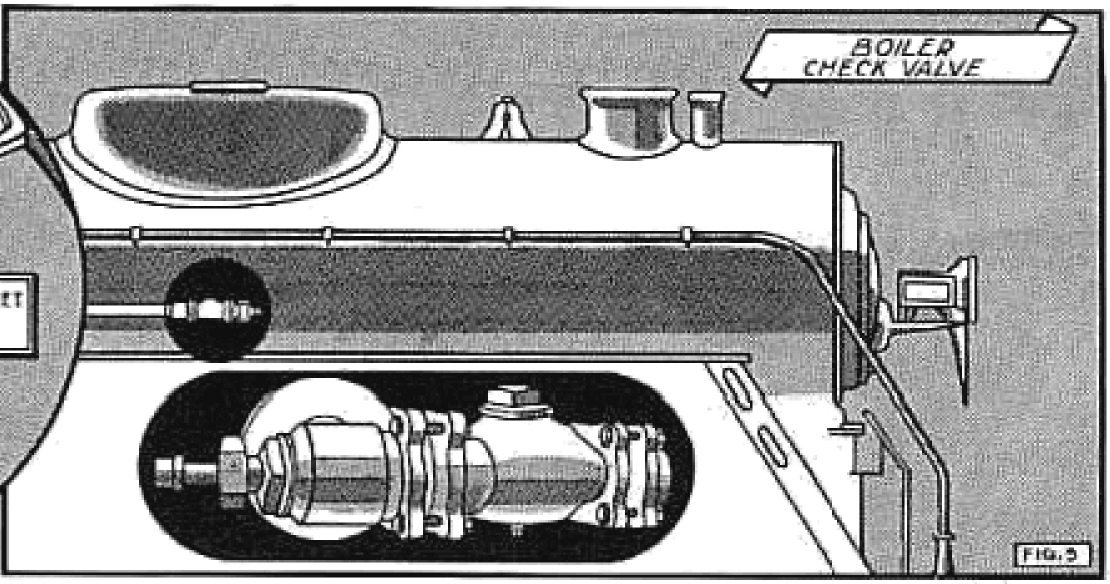


FIG.5

observe the delivery pressure indicated on the gage (Fig. 6). See pages 57 to 59 for kinds of gages.

5. Run the pump long enough to make certain that the water is actually entering the boiler. The water level should be raised on the water glass.

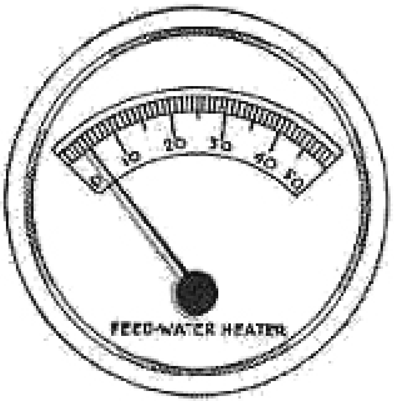


FIG.6

TESTING THE INJECTOR BEFORE LEAVING THE TERMINAL

1. See that the injector-overflow valve is open (Fig. 7).

2. Open the tank valve on the right side of the tender (Fig. 3).

3. Open wide the main valve on the turret (Fig. 4).

4. Check the boiler check valve (Fig. 5) to see that it is open. The injector does not use the same boiler check valve as the water pump.

5. Adjust the water-regulator handle (Fig. 7) to feed the desired water to the boiler without spilling at the overflow.

6. Shut off the injector by closing the steam valve and the overflow when correct operation is assured.

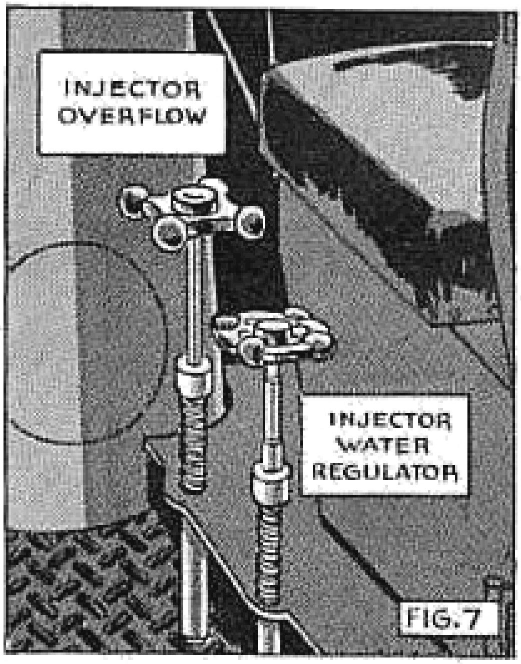


FIG.7

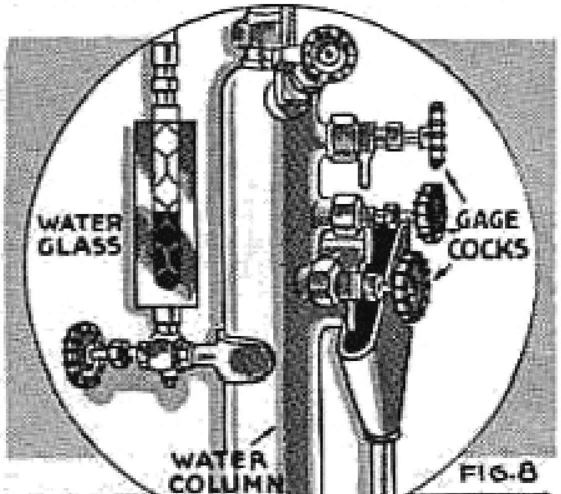


FIG.8

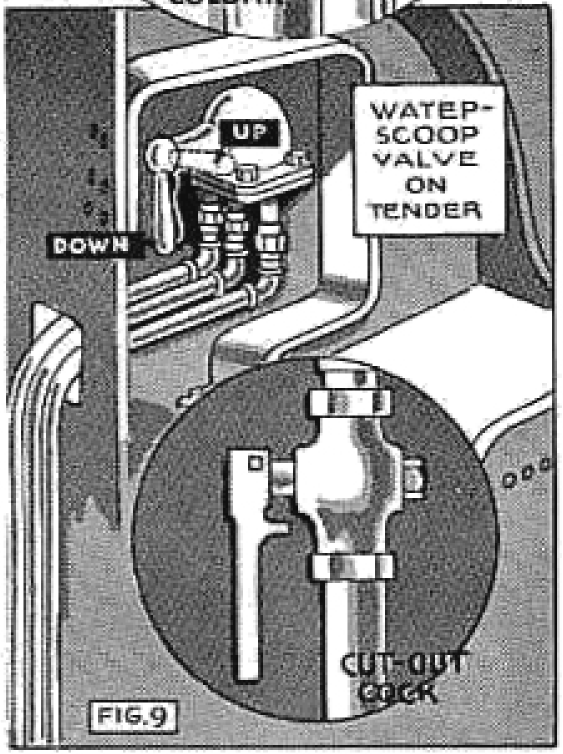


FIG.9

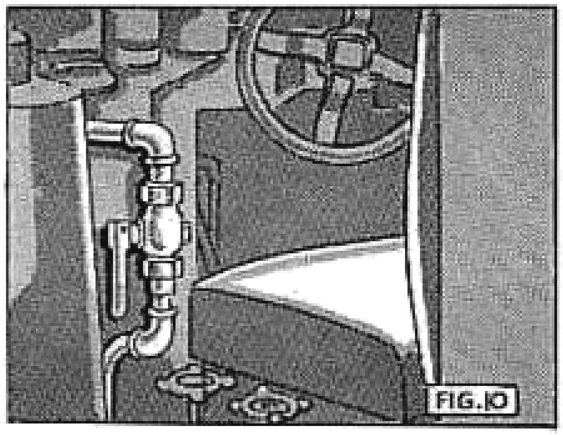


FIG.10

7. Check the level in the water glasses. The proper level should be "two gages" or approximately half a glass (Fig. 8)

   NOTE: When the locomotive is leaving the terminal and for the first four or five miles (about seven minutes), the injector should be used to supply water to the boiler until the feed-water heater becomes thoroughly heated and the firebox temperature is up. Then maintain the water level with the feed-water pump.

   CAUTION: Be sure that both the injector and the water-pump check valves are left open.

TESTING WATER SCOOP BEFORE LEAVING TERMINAL

1. Place the scoop-operating valve (Fig. 9) in its up, or non-operating, position.

2. Open the scoop cut-out cock near the engineman's seat box (Fig. 10).

3. Open the cut-out cock under the scoop-operating valve (Fig. 9).

4. Move the scoop-operating handle to center position to exhaust the air from the lifting side of the water-scoop piston head.

5. After all the air has been exhausted, move the handle slowly toward the drop position until the air is heard passing through the valve. Leave the valve in this position for a few seconds while the scoop drops slowly.

6. After the test is complete, return the scoop-operating handle to the up position.

   When scooping on the road, move the scoop-operating handle to the down position quickly in accordance with the engineman's signals.

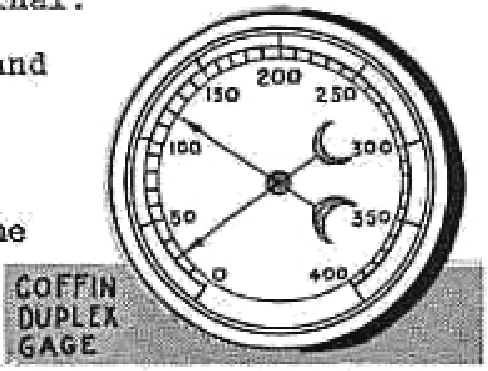
7. Close both "cut-out" cocks (Figs. 9 and 10).

NOTE: In winter weather turn on the "blowback" to the water scoop with sufficient strength to prevent freezing.

PUMPING THE BOILER WHILE LOCOMOTIVE IS UNDER WAY

The fire should be in good condition before the locomotive starts out on a run. The injector should be used for the first four or five miles, or for about seven minutes after starting out. This will bring the temperature of the brick arch and firebox up to normal and will give the feed-water heater time to become thoroughly heated. The feed-water pump should then be started, and the injector shut off. The water pump should be regulated to run at an even speed which will be just fast enough to keep the water level in the boiler at two gages (approximately one-half glass). The best superheat is obtained by this method of pumping the boiler. GOOD EVEN PUMPING OF THE BOILER IS ESSENTIAL TO GOOD FIRING.

1. Check to make certain that the following valves were left open after testing the pump and injector at the terminal:
   - a. The tank valves (Fig. 3) on both the right and left sides of the tender.
   - b. The main valve on the turret (Fig. 4).
   - c. The boiler check valves (Fig. 5) for both the injector and the water pump.
2. Open the pump-operating valve (Fig.11) slowly.



COFFIN DUPLEX GAGE

3. Regulate the water supply. The procedures for the Coffin closed-type, the Worthington open-type, and the Elesco closed-type systems are described in A, B, and C below.
   - A. The Coffin Closed - Type Feed-Water Heater System:
     1. Start the pump by opening the pump-control valve (Fig. 11) slowly. The red steam hand on the pump gage should rise to 25 or 30 pounds. The black water hand should then rise to the same point. Both hands should then rise to their respective operating pressures. When water is being supplied to the boiler, the black hand will be above boiler pressure and the reading of the red hand will be approximately 175 pounds.
     2. Regulate the water supply with the operating valves so that the proper water level will be maintained in the boiler by operating the pump at an even speed. AVOID SAW-TOOTH PUMPING.
   - B. The Worthington Open-Type Feed-Water Heater System:

1. Slowly open the pump-operating valve (Fig. 11) approximately one and one-half turns. This valve controls the speed of the hot-water pump and the amount of water delivered to the boiler.

2. Note the pressure on the cold-water pump-pressure gage (Fig. 6). The gage should indicate 10 to 25 pounds.

3. Adjust the pump-operating valve until the correct supply of water is being maintained with the pump running at an even speed.

C. The Elesco Closed-Type Feed-Water Heater System:

Reciprocating Pump

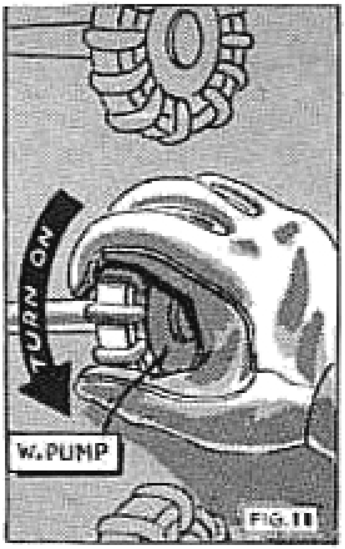


FIG. 11

1. Open the pump-operating valve (Fig. 11) slowly. The gage hand will have a regular swing when the reciprocating pump is operating properly.

2. Regulate the supply of water by controlling the speed of the pump. This is done by adjusting the operating valve until the gage-delivery pressure hand is above boiler pressure and maintains the correct amount of water in the boiler.

NOTE: Even pumping at a speed just fast enough to maintain the proper water level under all operating conditions is better than fast, intermittent pumping. Supplying cold water to the boiler too rapidly will cut down the boiler efficiency.

Centrifugal Pump

1. To start the pump, note first that the control valve is open; then open the operating valve slowly to bring the pump up to speed gradually. When the water is being supplied to the boiler, the gage-delivery pressure hand will be above boiler pressure (Fig. 12).

2. Regulate the water supply with the operating valve to maintain the proper water level in the boiler. Even pumping is essential to good firing.

MAINTAIN CORRECT WATER LEVEL

4. Look at the water glass frequently to check the level of the water in the boiler. There should be "two gages," or approximately one-half glass of water (Fig. 8).

TRIP MECHANISMS

The Elesco Feed-Water Pump and the Coffin Feed-Water Pump are both provided with a tripping mechanism to protect them from being damaged by overspeeding. If the pumps trip for any reason they must be reset.

HOW TO RESET THE ELESCO PUMP

a. Turn the handle in the cab (Fig. 12) to its closed position.

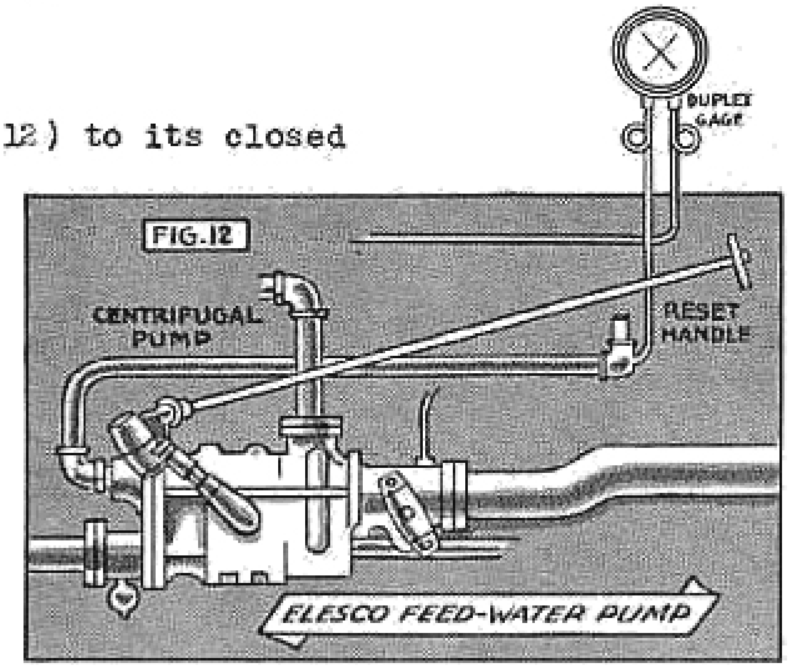


FIG.12

b. Restart the pump by opening the pump-operating valve slowly.

c. Check the following if a pump continually trips. (These are the usual causes of tripping.) Report the condition if you cannot correct it.

   1. Closed tank valve, clogged suction strainer or other obstruction in the suction line.

   2. Closed boiler check valve.

   3. Overheated suction water caused by suction-line heater being on too strong.

   4. Air leak in suction line.

   5. Pump requires overhauling and has to be operated at too high a speed to maintain water level in boiler.

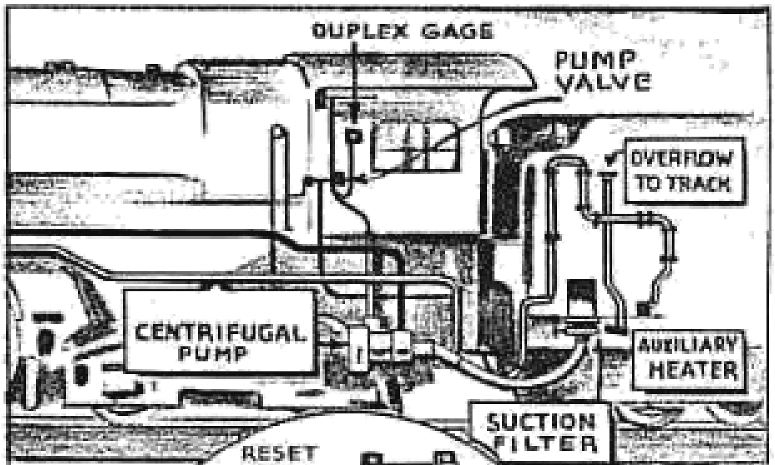


FIG.13

HOW TO RESET THE COFFIN PUMP

When the Coffin Feed-Water Pump "trips" or shuts off, reset the pump by the following procedure:

a. Close the control valve tightly (Fig. 13).

b. Wait one minute and turn the resetting wheel clockwise on the pump (Fig. 14) near the

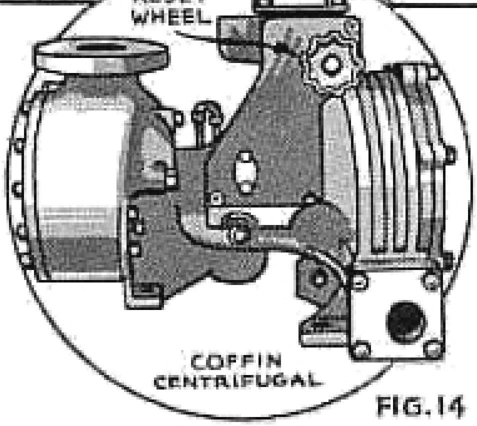


FIG.14

pump steam chest to the end of its travel (about 1-1/2 turns); then release it.

NOTE: If the resetting wheel can be turned easily, the pump resetting is completed.

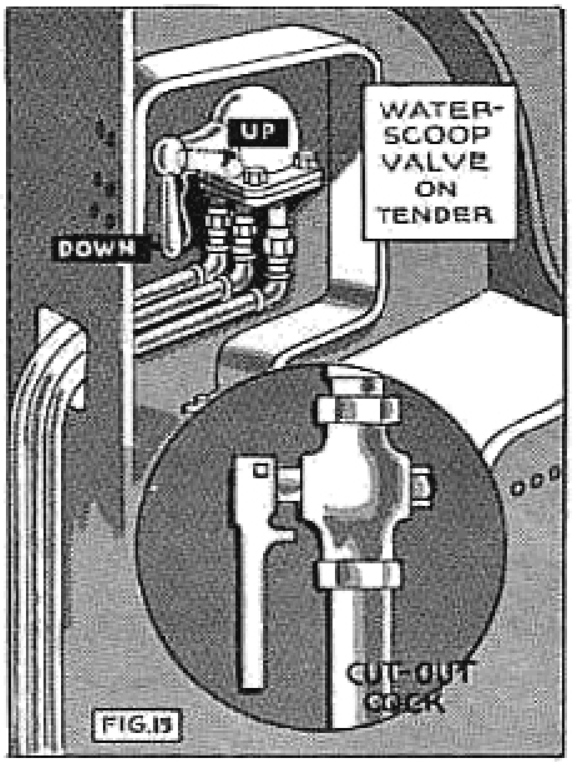


FIG.15

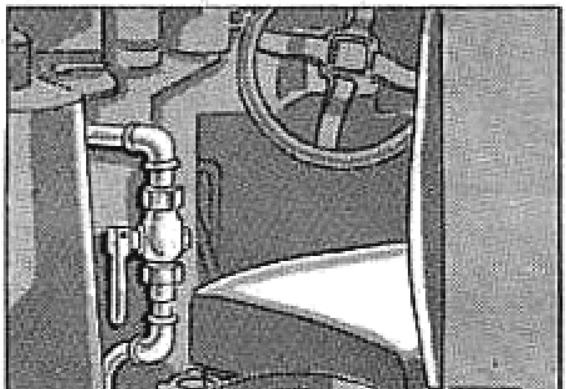


FIG.16

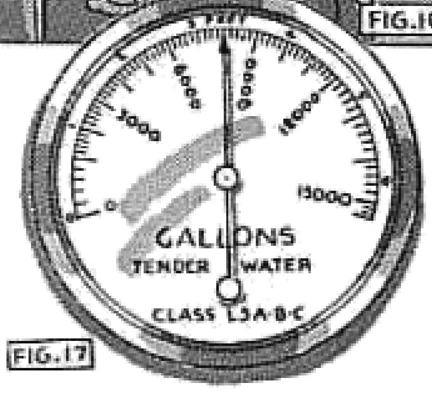


FIG.17

HOW TO SCOOP WATER

1. Before leaving the terminal, learn the location of places where water is to be scooped so that you can be ready to operate the water scoop when the signal is given by the engineman.

2. Take position at the operating valve on the front of the tender (Fig.15).

3. Cut in the scoop "cut-out cock" (Fig. 15).

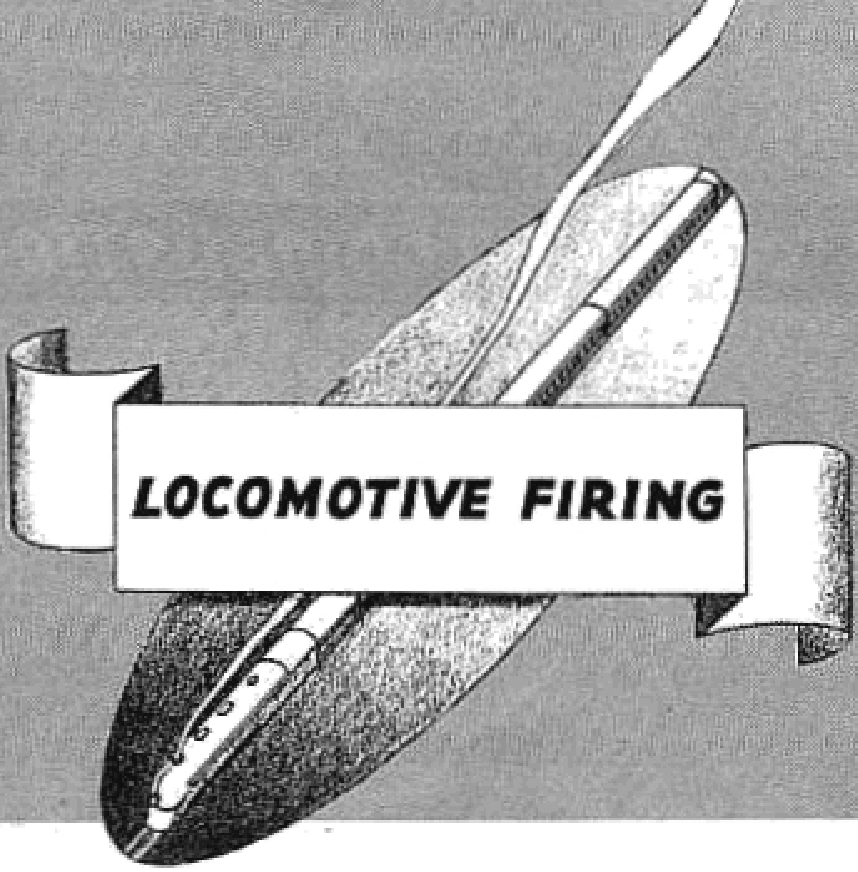
   NOTE: The engineman also "cuts in" the air to the water scoop by opening the scoop "cut-out cock" near the left front of the engineman's seat box (Fig. 16.)

4. When the engineman signals with his arm and calls DOWN, or signals with a whistle, move the handle (Fig. 15) to the down position to drop the scoop.

5. When the engineman signals with his arm and calls UP, or signals with a whistle, at the end of the pan, move the operating valve to the up position to raise the scoop.

6. Close the "cut-out cock" under the operating valve (Fig.15).

7. Check the water level in the tank (Fig. 17) by looking at the gage on the boiler back head and by trying the try cocks on the front of the tender. A careful fireman takes nothing for granted.



LOCOMOTIVE FIRING

COAL

UNIT I-6
Pages 70-77

UNIT P-6
Pages 78-84

UNIVERSITY OF THE STATE OF NEW YORK
STATE EDUCATION DEPARTMENT
BUREAU of INDUSTRIAL AND
TECHNICAL EDUCATION

UNIT I-6

COAL AND COMBUSTION

OBJECTIVES

1. To give some important information regarding conditions that affect combustion in the firebox of a locomotive.
2. To explain the properties of coal that cause different grades of coal to react differently when burned.
3. To explain what causes clinkers.
4. To suggest ways to prevent clinkers from forming.

INTRODUCTORY INFORMATION

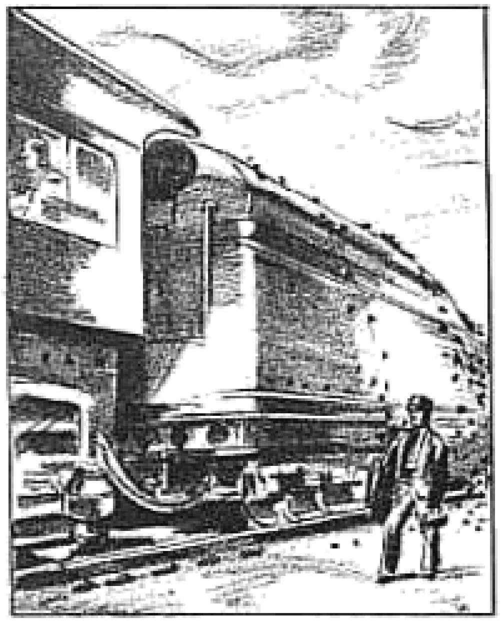
The fireman cannot tell by looking at the coal in the tender how well it will burn in the firebox. He must burn the coal to find out how well it will burn.

There are some conditions that can be observed that will help to get the greatest efficiency from coal. Some of these can be observed in the tender and some can be observed in the firebox.

Knowing what causes clinkers to form will enable the fireman to fire clinkering coal successfully by the skillful application of the rules of good firing.

WHAT TO LOOK FOR IN THE TENDER

BEFORE STARTING OUT ON A RUN



❶ See that the coal in the tender is trimmed to avoid the possibility of coal falling off and injuring someone, and to avoid wasting coal.

❷ Observe the coal in the tender to see whether it is lump or slack.

❸ Observe the condition of the coal to see whether it is wet or dry.

❹ Remove such things as pieces of rock, wood, or iron that might obstruct the stoker.

ON THE TRIP

Observe the coal in the tender occasionally. If the coal is wet or irregular in size, pay particular attention to the suggestions in Unit P-6, How to Fire Different Kinds of Coal.

Remove any foreign matter that may be in the coal to keep it from getting into the stoker trough.

WHAT TO LOOK FOR IN THE FIREBOX

Some grades of coal tend to clinker badly, to form a large amount of ash, or to produce excessive smoke. If the fireman knows that different grades of coal do have these tendencies, he can look for and learn to recognize the different conditions when he inspects the fire, and can then control his fire to avoid trouble or at least to offset the difficulty well enough to get satisfactory results.

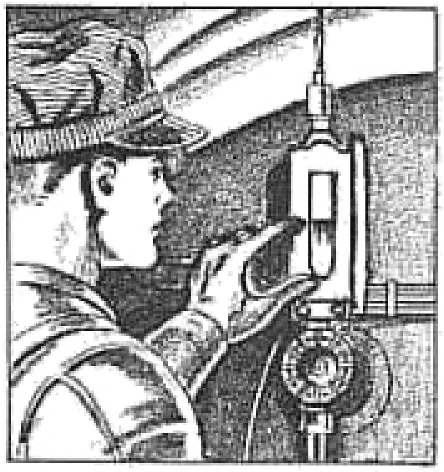
The general procedure, described in Unit P-6, How to Fire Different Kinds of Coal, is followed regardless of what grade of coal is being fired. However, an application of the special suggestions for different conditions as given in the same unit, plus an understanding of why different grades of coal behave as they do, will assist the fireman to get the best efficiency from all kinds of coal.

THREE THINGS MUST BE CONSIDERED AS ESSENTIAL TO GOOD FIRING

① Keep water in the boiler at the proper level by even pumping as described in Unit P-5, How to Pump the Boiler. Control the water supply to the boiler so that it will not be necessary to put a lot of water into the boiler at one time. Adding too much water at one time affects the steaming of the boiler.

② Maintain an even fire.

③ Feed coal to the fire according to the steam demand. The information given below explains why different kinds of coal require different treatment in the firebox to get the best results.



COAL AS FUEL

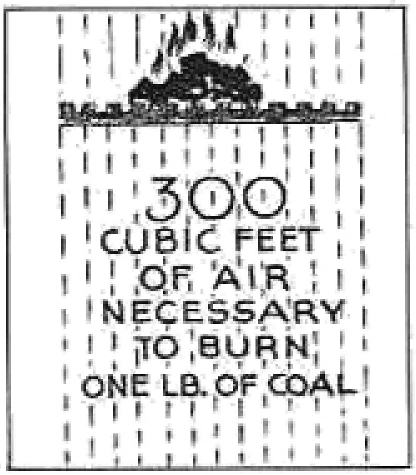
A fuel is any substance that will combine chemically with oxygen in a rapid process called burning or combustion. Heat and light are produced by this process.

Coal is a fuel made up principally of two elements, carbon and hydrogen.

The carbon in coal is found in two forms: fixed carbon, as the solid carbon of the coke is called; and free carbon, as the gaseous carbon of the hydro-carbon gases is called. Carbon occurs in all kinds of coal and is the principal source of heat. The amount of fixed carbon and free carbon found in different kinds of coal varies considerably and affects the behavior of the coal in the firebox.

Hydrogen is a gas, and, like oxygen or nitrogen, is transparent, colorless, odorless, and tasteless. It is the lightest substance in the world, burns with the hottest flame known, and has a great chemical affinity for oxygen.

COMBUSTION

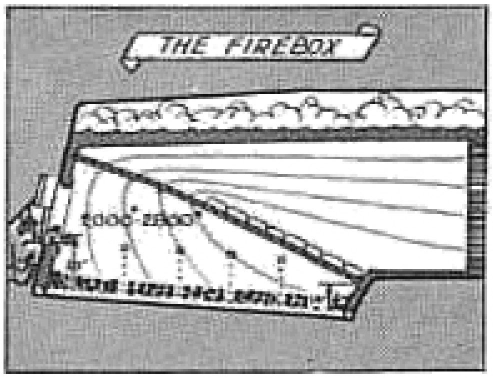


Combustion is a rapid chemical combination of oxygen of the air with any fuel, producing both heat and light. Three things are necessary to sustain combustion with coal as the fuel: (1) the combustible matter in the coal, (2) an adequate supply of oxygen brought into contact therewith, and (3) ignition which occurs at a relatively high temperature necessary for the fuel and oxygen to burn.

Approximately three hundred cubic feet of air are required to provide the oxygen necessary for the complete combustion of one pound of coal.

The ignition, or kindling temperature, of average soft coal is approximately 1800° Fahrenheit. The fuel must not only be heated to the kindling temperature, but it must also be kept at least as high as this temperature, or combustion will cease.

The element of time, or rate of combustion, is an important factor. In a locomotive boiler the rate of combustion per square foot of grate area per unit of time is relatively high under the forced draft necessary to evaporate water into steam by the heat liberated in burning the fuel. If the fire is not hot enough to burn the fuel rapidly, part of the fuel is unburned, passes out of the stack as black smoke, and is wasted.



The temperature in a properly drafted and properly fired coal-burning locomotive will range between 2000° and 2800° Fahrenheit at the center of the firebox. The temperature at the side and end sheets is lower because the temperature of the water on the opposite side of the sheets is lower than the temperature of the firebox.

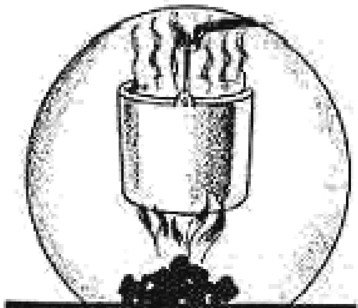
It is desirable to get as high a temperature as possible along the side and end sheets in order to develop the highest efficiency in steam generation.

Much information about the appliances that control the draft in a locomotive is given in the following units: Unit I-2, The Locomotive Boiler, Unit I-13, The Smoke Consumer and the Blower, and Unit I-7, Grates and their Function. Other facts that affect combustion are covered in other units in this book.

FACTORS AFFECTING COMBUSTION

Since it is good combustion that gets the heat out of coal to produce steam, some facts bearing on this subject are presented here. Some of these ideas have been covered in other units but they are so important that they will bear repeating.

The fire in the firebox should be as light on the grates as the work being done by the engine will permit, should be evenly distributed over the grates, and should be free from banks and clinkers.


IT TAKES ONE POUND OF COAL TO EVAPORATE ONE GALLON OF WATER

When coal is put into the firebox, the heat from the fire drives the volatile combustion gases from the coal. These gases are ignited as they pass through and over the bright fire, leaving coke to burn on the grates. To burn the gases, a bright, white, almost incandescent coke fire is necessary. Under good conditions the gases will be consumed a short distance before they enter the flues. If the gases are not consumed in the firebox they will burn only a short distance after they enter the flues of a boiler, because the water surrounding the flues absorbs heat so quickly that the temperature of the gas is lowered below the ignition point. Thus, most of the gases of combustion and the fine particles of carbon carried along by the draft, that are not burned before they leave the firebox (Fig. 1), are wasted. BLACK SMOKE at the stack consists of this unburned fuel, and indicates incomplete combustion. Production of black smoke can be controlled by careful and intelligent firing.

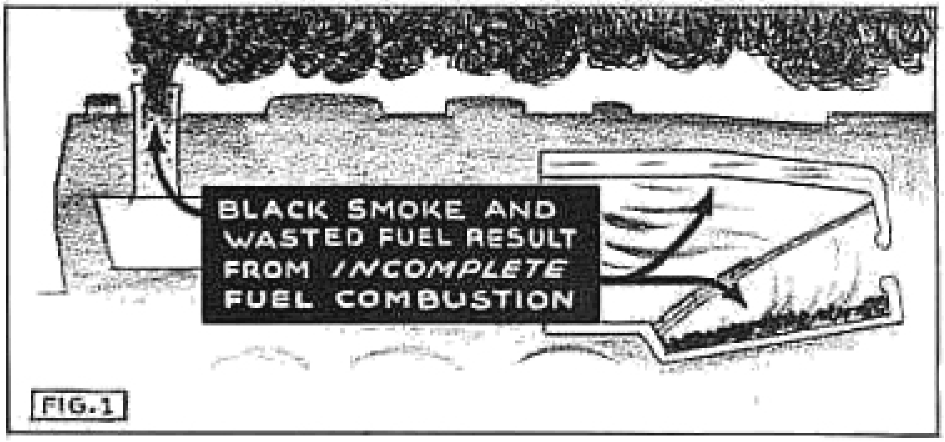

BLACK SMOKE AND WASTED FUEL RESULT FROM *INCOMPLETE* FUEL COMBUSTION

FIG. 1

Feeding coal to a bright fire too fast has the effect of temporarily deadening and cooling the fire, and causes the emission of quantities of BLACK SMOKE. The amount of gas that can be burned in a firebox under the existing condi-

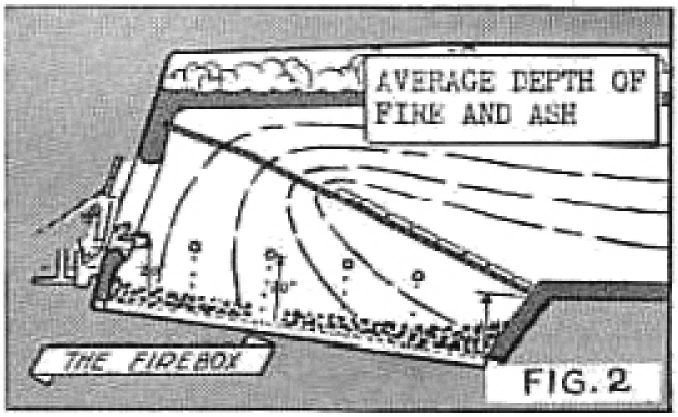


FIG. 2

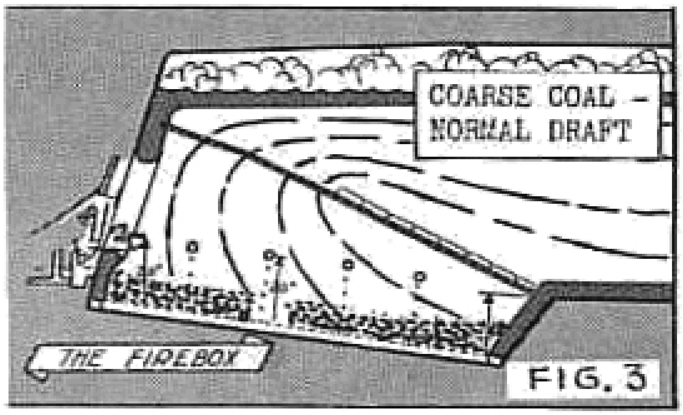


FIG. 3

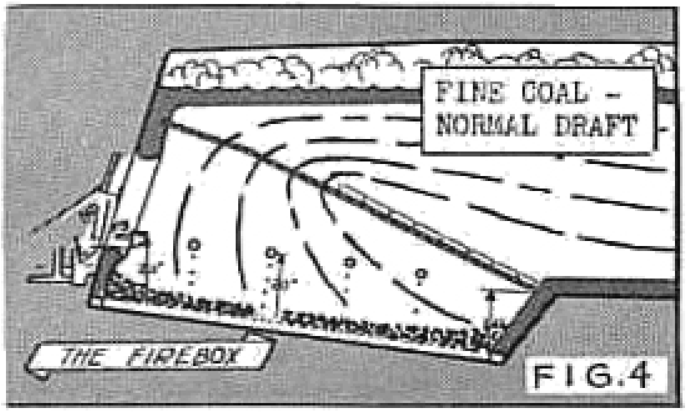


FIG. 4

tions of fire and draft is limited, and any gas in excess of that amount escapes from the stack as wasted fuel. The gases of coal are lighter than air and will pass away whether they are consumed or not. The slow burning of the coke is due to the fact that it burns from the outside only. Coal should be added by the stoker only as fast as the demand for steam requires it. The fireman can maintain the fire at the desired depth (Fig. 2) by supplying coal to the fire in just the quantity required to meet the demand for steam and by using the grates to remove the normal ash accumulation.

CONDITION OF COAL

The condition of the coal will determine to some extent how it should be fired.

Coarse (lump) coal (Fig. 3) may require a somewhat deeper fire than slack coal.

Slack (fine) coal (Fig. 4) is burned to a large extent in suspension and a somewhat lighter fire is maintained.

Mixed lump and slack coal requires more frequent inspection of the fire to make sure that an even distribution of the coal is maintained.

Wet coal requires watching, especially at the beginning of a trip, to see that it does not stick to the distributing table (Fig. 5) and that it is being evenly distributed to all portions of the fire.

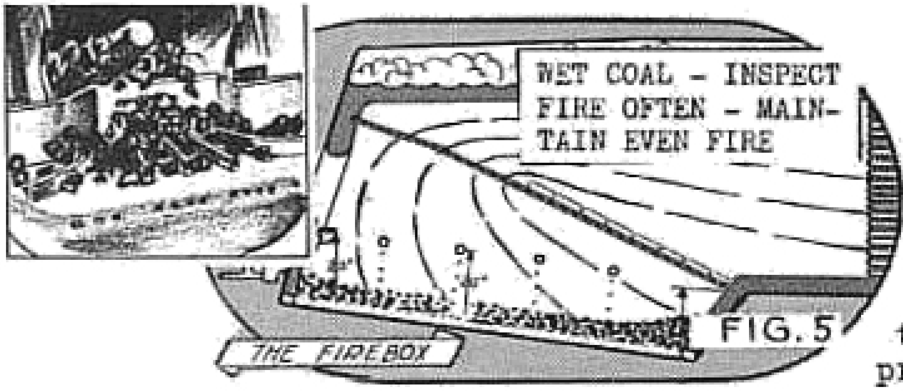


FIG. 5

ASHES

There is a great difference in the kind and quantity of ashes produced when coal from different mines is burned. Coal from one mine may produce very little ash; that from another mine may produce a large amount. The coal with the most ash will produce the least heat for each ton burned.

Ashes melt when they are subjected to a sufficient temperature, and when they melt they run together to form clinkers. Ashes from coal high in iron and sulphur content melt at a much lower temperature than the ashes from other kinds of coal. When the ashes tend to melt at a low temperature and form clinkers, the grates must be handled carefully to keep the fire clean. A clean fire will allow a good flow of air through the grates and thus help prevent the ashes from reaching the melting point.

It is important to keep the fire clean when a high-ash coal is being burned, for when ashes accumulate on the grate they restrict the flow of air through the fire.

CLINKERS

Clinkers are formed by improper firing which causes the ashes to melt. Most coal forms a caked clinker before the melting point of the ash is reached. If the clinker is discovered at this stage, it can usually be checked and burned out by good crew cooperation and skillful handling of the fire by the fireman.

A clinker in the fire bed of a locomotive boiler can cause serious difficulty and may cause a steam failure. Clinkers are treacherous because they may start to form without warning, and they grow rapidly after they have started. It is easier to prevent a clinker from forming than it is to get rid of it after it has started because the measures taken to clear out the clinker may actually make the condition worse.

As explained on page 74 in the section dealing with ashes, the tendency of coal to clinker varies considerably in coals mined in different localities. The clinkering tendency is governed by the kind of ash contained in the coal.

SUGGESTIONS FOR AVOIDING CLINKERS

Clinkers are formed by ashes high in iron and sulphur content that get too hot. Heating ashes beyond the clinkering temperature causes them to cake and eventually to melt and run together if the rise in temperature continues.

Keeping the ashes below the clinkering temperature prevents clinkering. The ashes on the grates and under the fire bed are cooled by air passing through the grates. A thick layer of ashes (Fig.

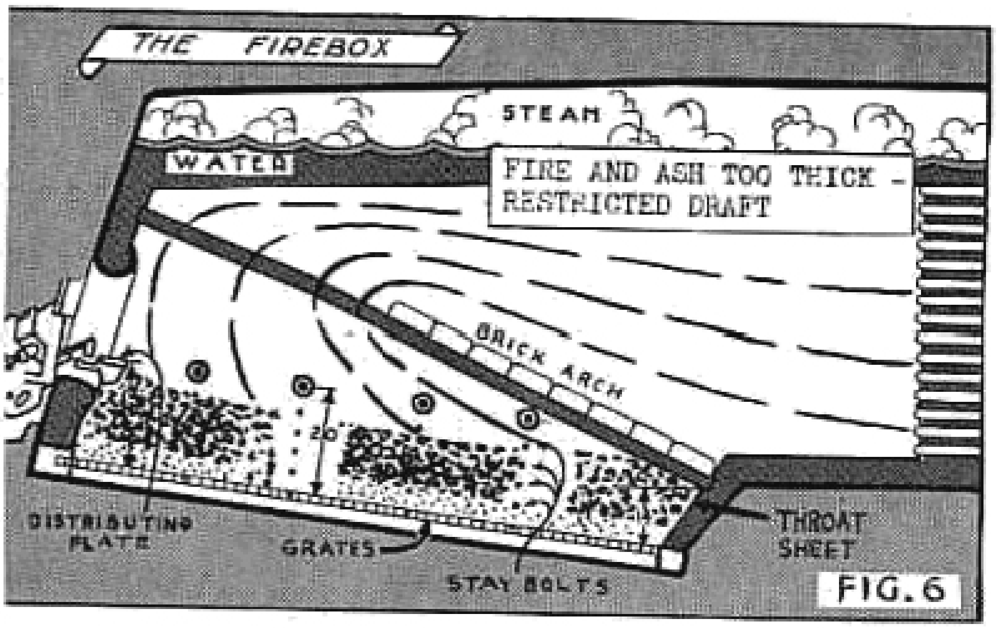


FIG. 6

6) may start a clinker because the flow of air is restricted.

When a thick layer of ashes is allowed to accumulate, the grates must be shaken excessively to clean the fire and thus the fire bed is disturbed. This action may work partially burned coal down into the ashes. The coal continues to burn and may raise the temperature of the ashes enough to start a clinker.

When clinkering coal is being fired, the fire bed should not be disturbed with the rake as this action may bring points of melted ash together, or mix ash already near the melting point with burning fuel, thus causing a clinker to form.

A bank can form a clinker because the air does not pass freely through that portion of the fire and, when this happens, the ashes under the bank may be heated to the melting temperature.

If a light spot develops in the fire bed, great care must be taken when coal is being added to build up the low area, for a large amount of fresh coal tends to form a clinker. Working fresh coal down into the fire by using the rake or by violent shaking of the grates may also start a clinker.

GENERAL FIRING INFORMATION

Carry as light a fire as possible to maintain the proper boiler pressure. This will depend on how hard the locomotive is being worked. If the fire is too thin, the draft is likely to tear holes in it. The steam pressure will fall if the fire is too thin.

A fire that is too thick (Fig. 6) is caused by too much ash on the grates. A thick fire slows up combustion by restricting the flow of air through the grates. A thick fire causes clinkering and prevents the fly ash from passing out of the stack.

Prepare the fire before reaching a heavy grade so that it will withstand the heavy exhaust. Cut down on the coal supply far enough before the start of a down grade so that the fire will be in good condition for light working conditions and so that the safety valves will not open.

The draft produced by the working locomotive controls the maximum amount of coal that can be burned in that locomotive. Feeding coal beyond this rate results in a thick fire. Feeding coal below this rate, results in reduced steam pressure. To maintain a fire of uniform thickness, more coal must be fed when more steam is being used and less coal must be fed when less steam is being used.

Stop firing far enough from a station to insure gases being consumed before the throttle is closed so as to reduce black smoke and prevent safety valves from opening.

THE PRINCIPAL CAUSES OF WASTED COAL

① Coal in tender not properly trimmed.

② Allowing coal to fall out of gangways. Do not let coal fall from scoop.

③ Leaving door open too long.

④ Using blower too strong.

⑤ Firing faster than coal can be burned.

⑥ Allowing safety valves to open.

⑦ Fire not hot enough for perfect combustion.

WASTED COAL IS WASTED MONEY—

SELECTED REFERENCES

Examinations for Firemen and Hostlers	New York Central System
Instructions for the Preparation and Maintenance of Locomotive Fires	New York Central System
Traveling Engineers' Examination Book	Railway Fuel and Traveling Engineers' Association
Locomotive Cyclopedia	Simmons, Boardman Pub. Co.

HOW TO FIRE DIFFERENT KINDS OF COAL

OBJECTIVES

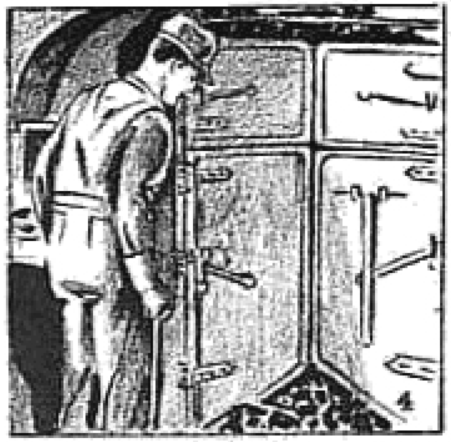
1. To emphasize the importance of following the same general procedure to get good results from all kinds of coal.

2. To give the general procedure to be followed to get best results from a stoker-fired locomotive.

3. To stress the fact that good firing saves coal.

4. To give suggestions that will help when firing different grades, sizes, and conditions of coal.

INTRODUCTORY INFORMATION



The job of firing a locomotive would be a relatively simple procedure if the fireman was assured of having coal of good quality, size, and condition to fire. However, this is not the case because a desirable grade of coal is not always available. Therefore, the fireman must be prepared to fire inferior coal under unfavorable conditions.

There are some standard practices which apply to all firing situations which, if followed, will save considerable trouble for the fireman and enable him to get good efficiency from the locomotive he is firing.

STANDARD FIRING PRACTICES

① Carefully observe the coal in the tender and at the point of distribution.

② Maintain an even stoker speed to keep the fire at the minimum depth that will maintain the required boiler pressure.

③ Set the stoker-jet pressures to maintain an even distribution of coal over the whole fire. Change pressures as necessary if the grade, size, or condition of coal delivered to the distributing table changes.

④ Inspect the fire frequently and correct unsatisfactory conditions.

⑤ Hand fire the light spots when necessary to maintain a level fire.

⑥ Move the grates frequently.

⑦ Maintain correct water level at all times by even pumping.

⑧ Fire according to the conditions under which the locomotive is being worked.

⑨ Avoid excessive use of the fire rake.

⑩ Call the engineman's attention to bad fire conditions so that the locomotive can be worked accordingly.

Wet coal, high-slack coal, clinkering coal, and high-ash coal can be successfully fired if the above practices are observed, together with the suggestions given in this unit for the different kinds of coal.

EQUIPMENT REQUIRED

Standard equipment as specified by local instructions

HOW TO FIRE DIFFERENT KINDS OF COAL

PROCEDURE

STANDARD FIRING PROCEDURES TO BE FOLLOWED AT ALL TIMES

1. Observe the condition and size of the coal at the point of delivery. The jet setting will vary according to the size and condition of the coal being burned.

   Do not allow rock, iron, wood, or other foreign matter to be fed into the stoker if it can be detected in the coal and removed before it enters the conveyor.

   Unit I-6 gives information on the kinds of coal and their effect on combustion.

2. Prepare the fire before starting out as explained in Unit P-1, How to Prepare the Fire.

3. Start the stoker after the locomotive is under way according to the instructions in Unit P-3, How to Operate the Stoker.

4. Set the stoker jets as explained in Unit P-4, How to Adjust Stoker Jets.

5. Adjust the stoker to run at an even speed. When small lumps and slack coal are being fed into the stoker, less steam pressure is required to maintain an even supply of coal to the distributing table than when coal containing large lumps is being used. More power is required when lumps of coal are being broken by the crusher.

   NOTE: An even stoker speed makes possible an accurate setting of the stoker jets.

6. Check the speed of the stoker by observing the amount of coal being delivered to the distributing table. The amount of coal required to keep the fire in proper condition depends on the conditions under which the locomotive is being worked and on the kind of coal being fired. Close observation of conditions in the firebox and of the conditions under which the locomotive is working will enable the fireman to make adjustments, if necessary, to get the best efficiency out of every ton of coal burned.

7. Keep a constant check on the gages listed below. Changes in readings tell a story that enables the fireman to take steps to correct conditions that affect the fire before they become serious.

   a. Boiler-pressure gage (Fig. 1) - A change in boiler pressure may require a change in the volume of coal to maintain the correct boiler pressure, and an adjustment of the stoker jets to maintain an even distribution of the coal. A change in boiler pressure may require attention to the fire to bring the pressure up if it is dropping, or may require a reduction in the amount of coal supplied to the fire to avoid popping.

   b. Pyrometer (Fig. 1) - A drop in reading indicates too much water in the boiler, engine foaming, or bad fire conditions. (See Unit P-11, How to Interpret Pyrometer Readings.)

   c. Water glasses and gage cocks (Fig. 1) - Low water can cause serious damage to the crown sheet and may endanger life. High water spoils the SUPERHEATING EFFECT of the locomotive and DESTROYS LUBRICATION. The water level in the boiler should not exceed two gages at any time.

   d. Stoker distributor jet gages (Fig. 1) - A study of these gages will make it possible to set jets for even distribution of the coal to all parts of the firebox. A frequent check of the coal being fired to detect a change in size or condition will make it possible to adjust jet pressures before the fire is affected. When the jets are to be shut off, note the pressure shown on the pressure gages so that jet operation may be resumed with the same pressure if desired.

e. Stoker-engine gage (Fig. 1) - Fluctuation of this gage gives an indication of what is happening in the tender conveyor unit and crusher and gives an indication of the speed at which the stoker is running. If the gage reading goes up approximately to boiler pressure and stays there, it is an indication that the stoker has stopped. This may be due to a foreign substance lodged in the stoker or to lack of lubrication.

8. Add water to the boiler at an even rate to maintain two gages of water as indicated by the water glasses and gage cocks. (See Unit P-5, How to Pump the Boiler, for instructions.)

9. "Move" the grates often to prevent an accumulation of ash on the grates, to avoid clinkers, and to maintain the proper fire depth. (See Unit P-7, How to Shake the Grates, for instructions.)

10. Flush the ash pan, if conditions permit, immediately after shaking the grates, to prevent damage to the grates or grate-bar connectors by the ashes building up on the wings of the ash pan. (See Unit P-9, How to Use the Ash-pan Flusher, for instructions.)

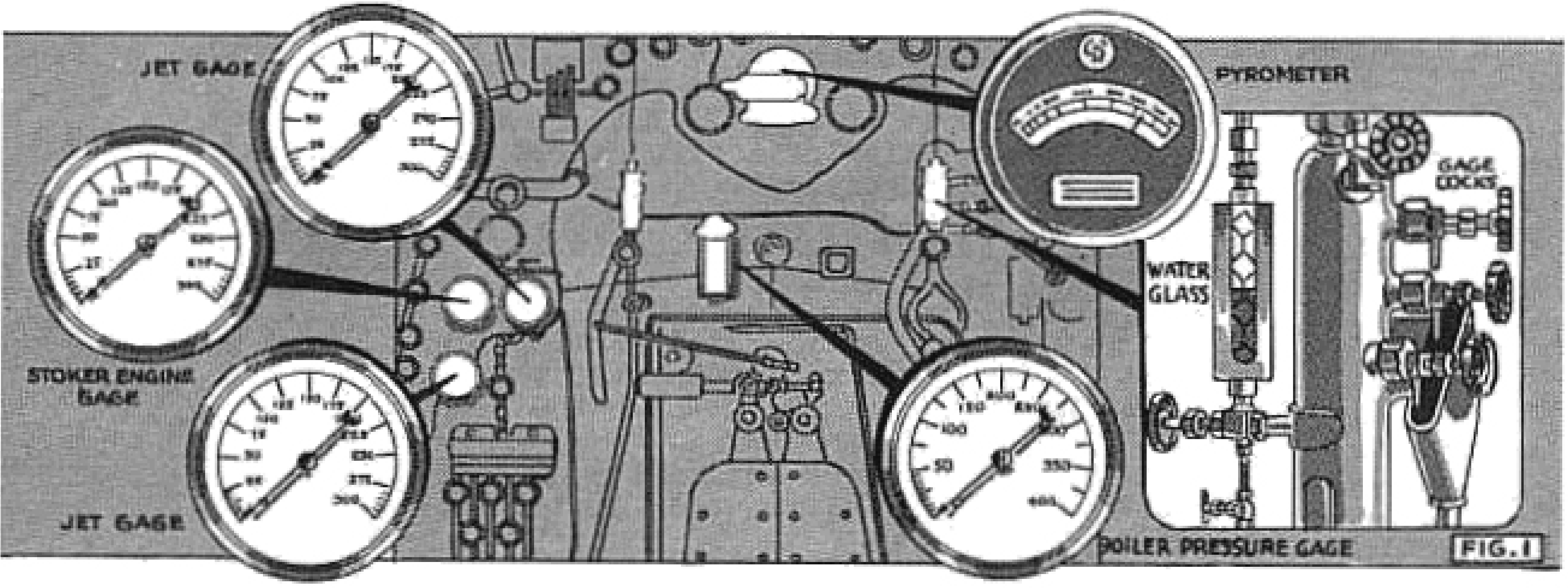


FIG. 1

11. Blow down the locomotive with the manual blowdown in accordance with local instructions. (See Unit P-10, How to Use the Manual Blowdown.)

12. Inspect the fire often. The frequency of inspection will depend on the kind of coal being used and how the locomotive is being worked. A bad condition can be corrected before it causes serious trouble if it is discovered soon enough. (See Unit P-2, How to Inspect the Fire, for instructions.)

13. Adjust stoker speed, stoker-jet pressures, or vanes as required to improve the fire and thereby maintain an even boiler pressure. (See Unit P-8, How to Correct Bad Fire Conditions, for instructions.)

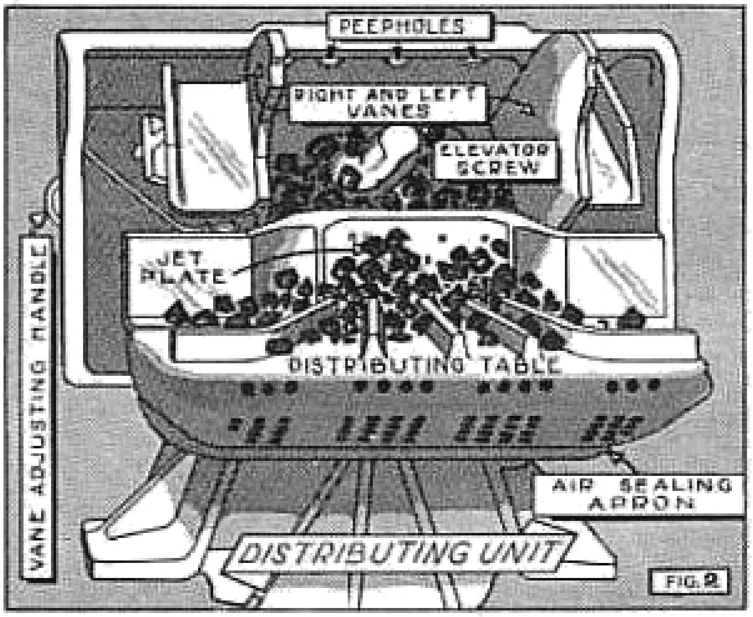


FIG. 2

SUGGESTIONS FOR FIRING WET COAL

Follow the standard firing procedure outlined in the first part of this unit, and apply the following suggestions:

1. Inspect the fire frequently. When the coal is wet, the even distribution of the coal over the fire is more likely to be affected because of the tendency of wet coal to stick together or to stick to large pieces.

2. Adjust the jets, if necessary, to slightly higher than normal pressures as wet coal tends to stick to the distributing table (Fig. 2). This condition is more noticeable at the beginning of a trip before the distributing table is heated thoroughly.

3. Use the jet hook or poke-out rod to dislodge the coal from the distributing table if it starts to stick to the table, even after the jet pressures have been increased. Wet coal has a tendency to bake on the distributing table if not removed. If it is allowed to accumulate, the increased jet pressure may blow the coal back under the arch.

4. Inspect the fire after each adjustment of jet pressures to make certain that the coal is being distributed evenly.

SUGGESTIONS FOR FIRING HIGH-ASH COAL (FLUFFY-ASH AND HEAVY-ASH)

Follow the standard firing procedure outlined in the first part of this unit, and apply the following suggestions:

1. Fire high-ash coal as light as possible. A good flow of air through the fire will carry the fly ash out of the stack.
2. Move the grates often to prevent the accumulation of ash.
3. Inspect the fire often.

   NOTE: A light-ash fire is more likely to "walk ahead" on the grates. This is caused by vibration and the sloping of the grates.

SUGGESTIONS FOR FIRING CLINKERING COAL

Follow the standard firing procedure outlined in the first part of this unit, and apply the following suggestions:

1. Adjust the stoker speed to avoid crowding the fire. Crowding the fire increases the tendency to produce clinkers and causes excess smoke.
2. Adjust the stoker jets to get an even distribution of coal and to prevent banks from forming. Banks shut off the air through the thick portion of the fire and thus a clinker forms and gradually grows.
3. Avoid the use of the fire rake with clinkering coal. Use it only in emergencies as the rake causes the clinkering substances to run together to form a bad clinker.
4. Move, or "wiggle," the grates often to insure a free flow of air through the fire. Do not shake grates violently.
5. Inspect the fire often. It is easier to correct a clinkering condition before it becomes serious than it is to get rid of a bad clinker.

SUGGESTIONS FOR FIRING HIGH-SLACK (FINE) COAL

Follow the standard firing procedure outlined in the first part of this unit, and apply the following suggestions:

1. Adjust the jets and vanes, if necessary, to control the distribution of the coal to the back corners. The stoker screw

tends to deliver more fine coal to the right and more lump coal to the left when the two are mixed.

2. Carry a slightly heavier fire at the back portion of the firebox. It is good practice to use the scoop to build up the back portion of the fire.

3. Adjust the jet pressures if the coal changes from fine to lump or from lump to fine.

NOTE: When the coal changes from fine to lump, the jet pressures should be increased or the coal will pile up in the back portion of the fire (Fig. 3).

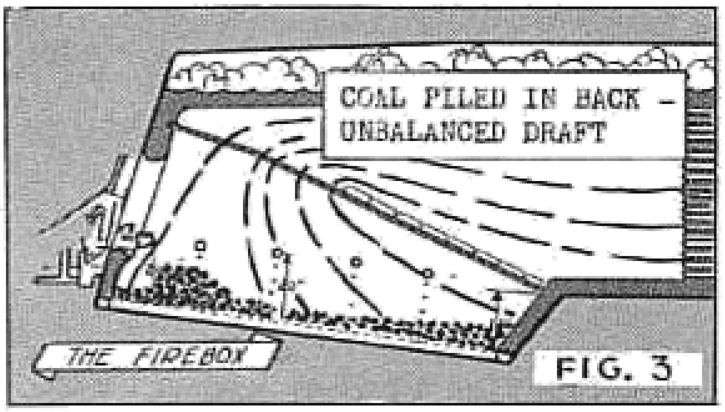


FIG. 3

NOTE: When the coal changes from lump to fine, the jet pressures should be decreased or the coal will be carried to the front of the firebox and perhaps cause a plugged arch (Fig. 4).

5. Inspect the fire after each adjustment of the vanes, stoker jets, or stoker speed to make certain that the coal is being distributed evenly.

NOTE: Watch for drifts and banks when there is slack coal mixed with lump coal.

6. Give close attention to the supply of coal in the tender and at the point of delivery to the firebox to observe its size and condition, so that need for adjustments can be anticipated, and made if necessary, before the fire is affected by changes in the coal being supplied by the stoker.

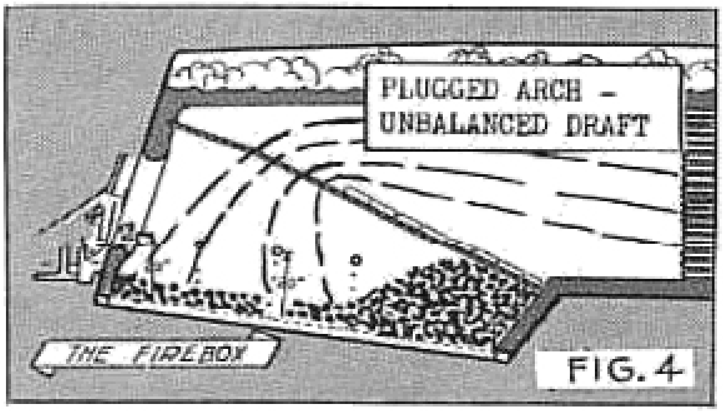
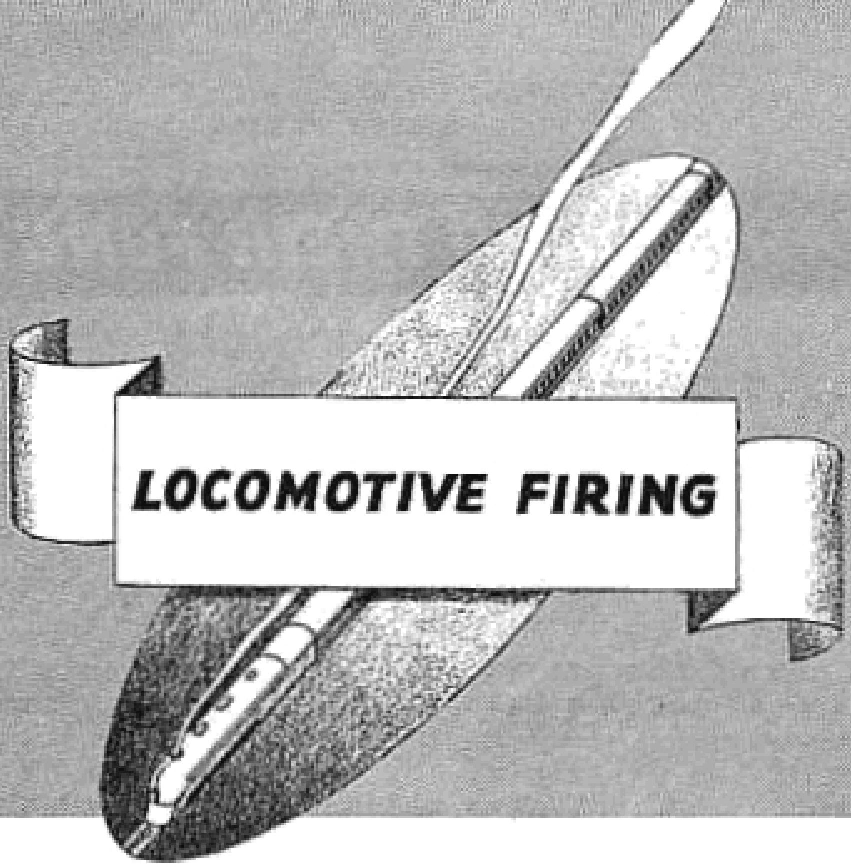


FIG. 4



LOCOMOTIVE GRATES

UNIT I-7
Pages 86-89

UNIT P-7
Pages 90-96

UNIVERSITY OF THE STATE OF NEW YORK
STATE EDUCATION DEPARTMENT
BUREAU of INDUSTRIAL AND
TECHNICAL EDUCATION

GRATES AND THEIR FUNCTION

OBJECTIVES

1. To describe how grates are constructed.
2. To show how the proper use of grates promotes good firing.
3. To stress the importance of using the grates correctly.

INTRODUCTORY INFORMATION

The proper use of the grates will help the fireman to maintain a good fire and to get the best results from all kinds of coal.

A knowledge of the details of construction, such as the general types of grates, and the size and shape of the openings through the grates will give the fireman a better understanding of the importance of correct grate operation and the effects that it has on the fire.

GENERAL INFORMATION

The proper use of grates requires careful consideration of two important factors. The first is to use the grates to keep the fire in good condition. The second is to use the grates so that they will not be warped, burned, or broken by misuse or carelessness.

The design of the grate bars makes provision for the essential functions of the grate: (1) to get rid of the ashes, and (2) to permit the air to pass through the fire.

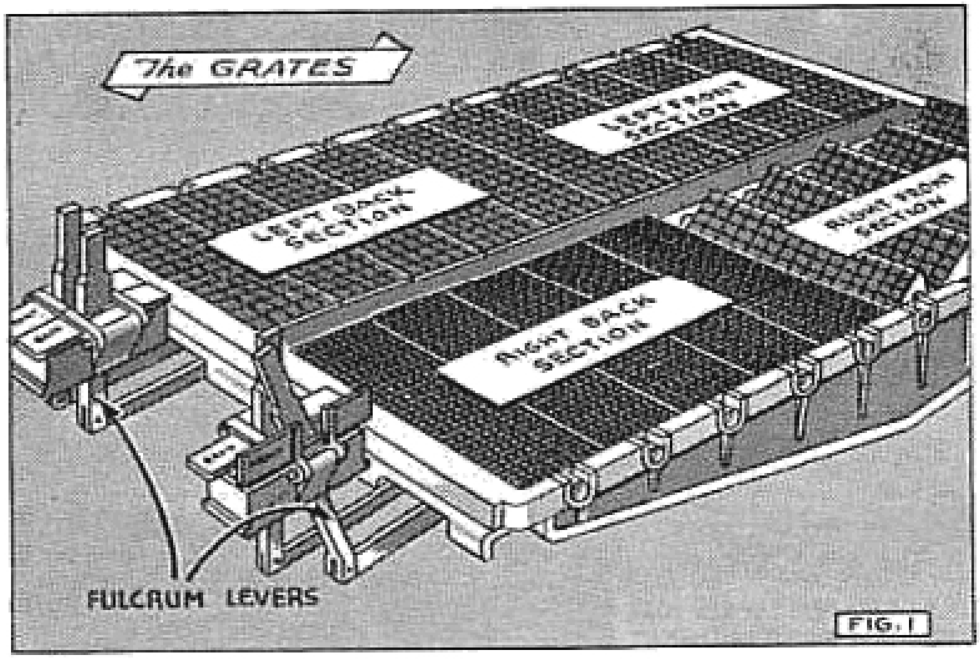


FIG. 1

The grates are usually made in four sections, and are shaken by shaker rods connected to a fulcrum lever (Fig. 1). Each section is moved separately, and usually it is desirable to move the front grates first to make an even distribution of the draft through the fire.

The grate bars are shown in Fig. 2. They carry a number of sections so constructed that when they are assembled on the bar, numerous tapered openings permit the ash to pass through when the grates are moved. The size of the openings govern the amount of air passed through the grates in proportion to the grate area.

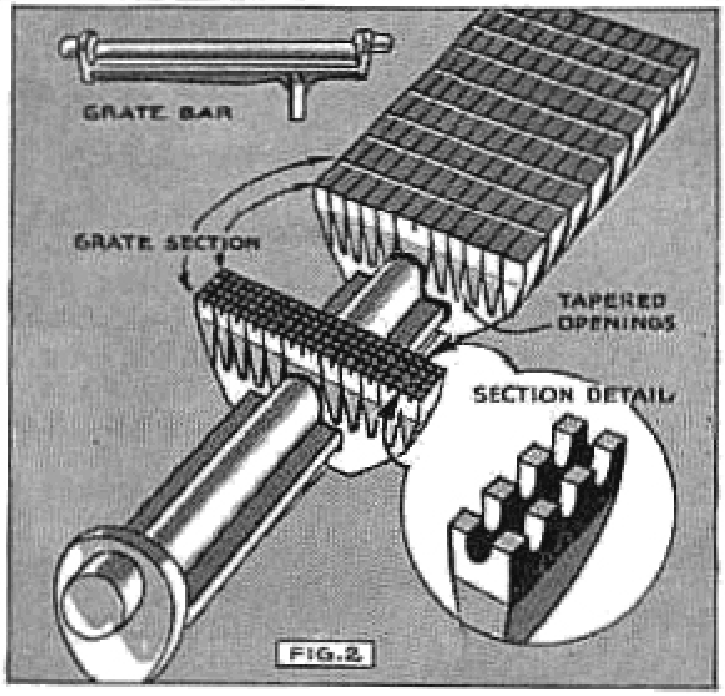


FIG.2

The fire should be kept light and clean. A light, clean fire can be maintained by getting rid of the ash produced by the burned coal as fast as it accumulates.

Regardless of the type of grates, their chief function is to assist in keeping the fire light and clean (Fig. 3). Keeping the fire bed light and clean prevents clinker formation and results in practically smokeless combustion.

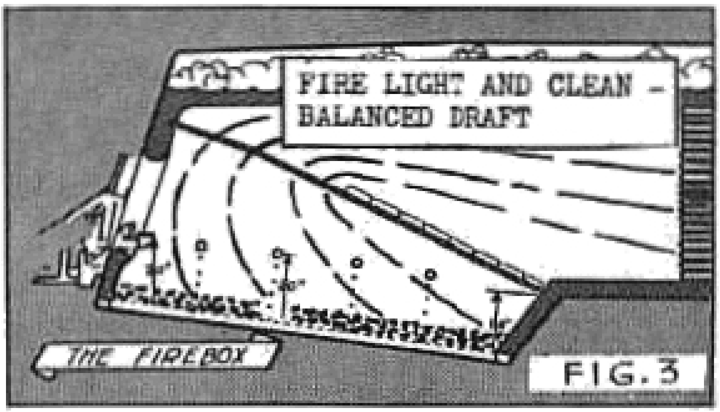


FIG. 3

To maintain a clean fire and to avoid smoke, the fire should be starved as much as possible and still maintain the correct boiler pressure.

The depth of fire and ash on the grates will gradually increase while the engine is being worked hard. This results in a dirty fire and clinker trouble. However, through proper use of the grates the fire can be kept as thin as the work being done by the locomotive and the grade of coal burned will permit.

Banks should be leveled before the stoker is started. If a bank forms after the stoker is started the grates should be shaken under the bank to get air through the thick area. The use of the rake should be avoided if possible. There should be no reason for using the rake if the fire is carried level and clean from the start and if the stoker speed and jet pressures are skillfully adjusted.

Stoker firing produces an ash clinker rather than a coal clinker because of the thin, hot fire bed that is maintained. Stirring the ashes up into the fire will certainly cause a clinker.

The stoker does the heavy work of firing a locomotive but does not have the brains and judgment necessary to control the fire. The thin fire carried when firing with a stoker makes it necessary to use the grates carefully.

USE OF THE GRATES

There are three degrees of movement used by firemen when shaking grates: wiggling, shaking, dumping. All three terms, however, mean shaking. Shaking the grates properly is a very important factor in keeping the fire in good condition. This requires GOOD JUDGMENT on the part of the fireman.

The three degrees of grate movement are:

1. Wiggling - light shaking - moving or rocking
2. Shaking - half stroke or half open
3. Dumping - full stroke or full open

The first degree of grate movement, which is the most frequently used method of operating the grates (Fig. 4), consists of "moving" the grates often. This action scrapes the bottom of the fire bed and drops the heavy ash through the openings in the grate sections while the draft through the fire bed carries the light ash out through the stack. The grates should be moved while the locomotive is working light. This combination of slight grate movement and light draft does not disturb the fire bed.

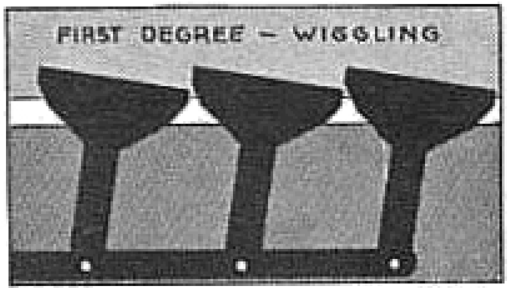


FIG. 4

Keep the fire light and clean and increase the supply of coal if the fire gets too thin for the conditions under which the locomotive is working.

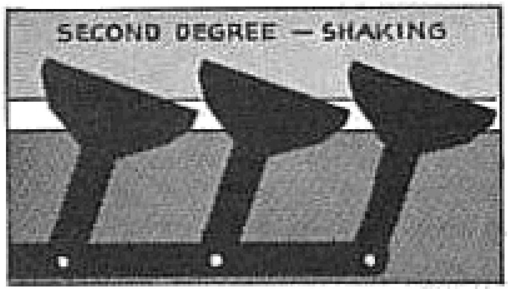


FIG. 5

The second degree of grate movement (Fig. 5) consists of using a little longer stroke on the shaker handle and "shaking" the grates to work large accumulations of ashes, small clinkers, and slate through the grates.

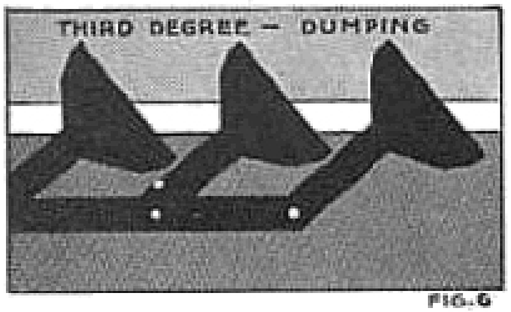


FIG. 6

This action reduces the depth of the fire rapidly and, because of the lifting action of the grates, has a disturbing effect on the fire. A short time should be allowed after shaking each section of the grates to let the fire settle down before the next section is shaken to avoid disturbing too much of the fire at one time. Proper use of the first method of

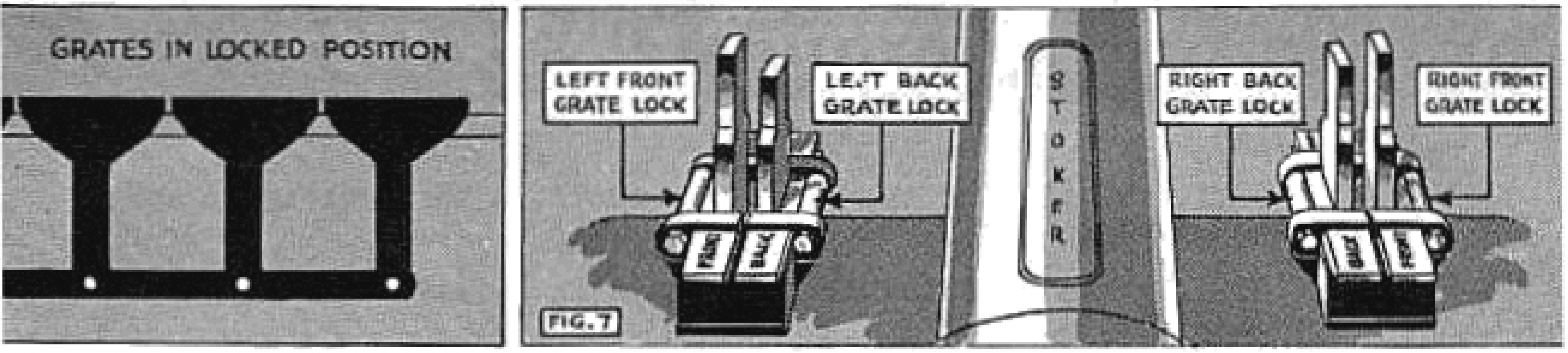


FIG. 7

moving the grates will reduce the need for the second method to a minimum.

The third degree of grate movement is the dumping method which involves the use of the full-length stroke and opens the grates several inches (Fig. 6). This action is used when it is necessary to clean or dump the fire.

CARE OF THE GRATES

Ash accumulations in the ash pan should be kept away from the grates and shaker rods to avoid burning or warping them. This can be done by proper use of the ash-pan flusher. A free flow of air through the grates keeps the temperature of the grates down, and therefore it is not necessary to maintain a bed of ashes on the grates to protect them from the heat of the fire bed.

The grate-shaker levers in the cabs are provided with a locking device which assures that the grates are flat when the lock is in place (Fig. 7). Keeping the grates flat prevents unburned coal from falling through and avoids burning the grate sections. This might happen if an edge of the grate is turned so that it projects up into the fire.

SELECTED REFERENCES

Examinations for Firemen and Hostlers	New York Central System
Instructions for the Preparation and Maintenance of Locomotive Fires	New York Central System
Traveling Engineers' Examination Book	Railway Fuel and Traveling Engineers' Association
Locomotive Cyclopedia	Simmons, Boardman Pub. Co.

Pamphlets supplied by grate manufacturers

HOW TO SHAKE THE GRATES

OBJECTIVES

1. To call attention to the safety precautions to be observed when shaking grates.

2. To explain the function of the grates in maintaining the fire in good condition.

3. To explain how grates should be shaken.

INTRODUCTORY INFORMATION

The proper use of the grates (Fig. 1) is an important factor in maintaining a good fire and will eliminate considerable trouble if the correct procedure is followed. The frequent movement of the grates will prevent the accumulation of ash, will maintain a clean fire, will prevent the formation of clinkers and thus will help control and equalize the draft. The grates are used to assist in controlling the depth of the fire which should be ten inches or less. The fireman should understand that the second ten inches (ten to twenty inches) builds up twice as fast as the first ten inches because the fly ash or fine particles are not carried off by the draft if the fire is too deep.

The grates should be shaken only enough to keep the fire clean, to maintain the proper depth, and to maintain an even draft (Fig. 2). Grates should be moved or rocked often, instead of violently shaken at infrequent intervals. It is desirable to move the front grates first if all sections are to be shaken, as changes in speed, the vibration of the locomotive, and the angle of the grates tends to cause the fire to work ahead and become thicker on the front grates. Grates should be shaken while the locomotive is being "worked light" because shaking disturbs the fire.

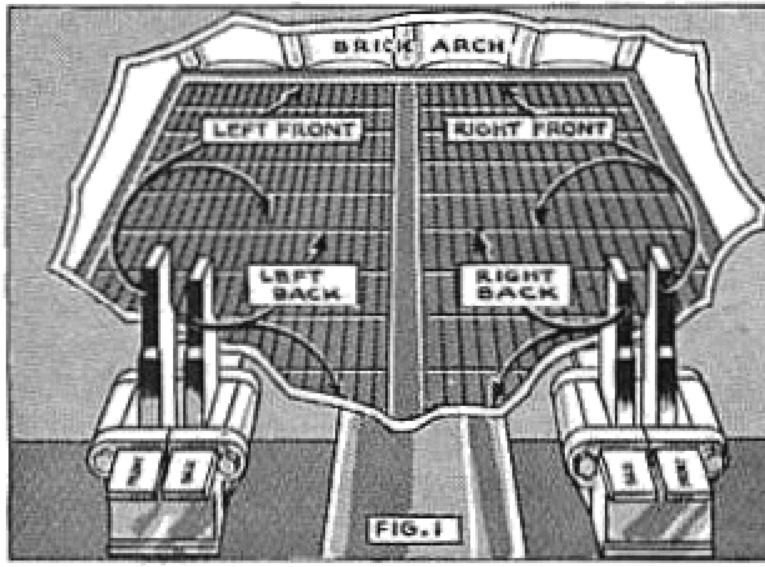


FIG. 1

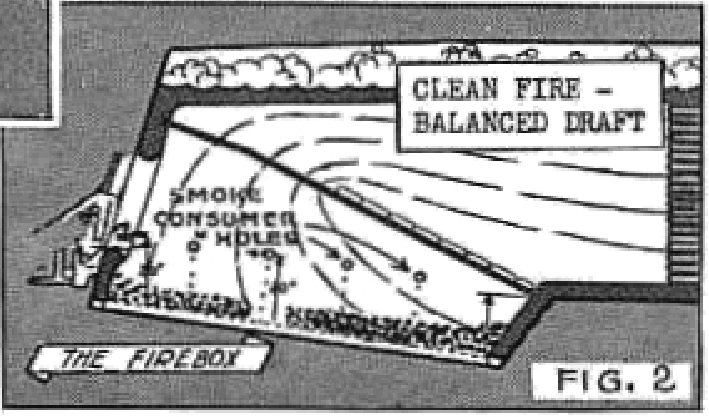
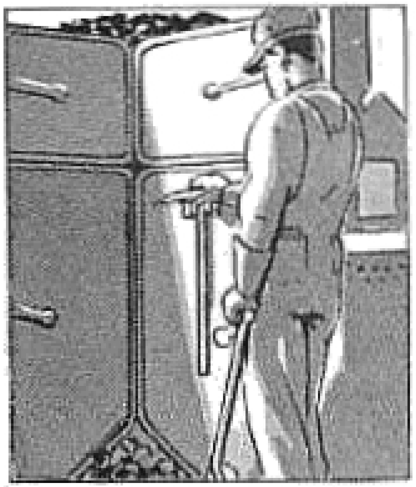


FIG. 2

EQUIPMENT REQUIRED

Standard equipment as specified by local instructions



GENERAL PROCEDURE FOR OPERATING THE GRATES

1. Shut off the stoker to let the gases pass off preparatory to inspecting the fire.

2. Apply the smoke consumer to burn off the gases so that a complete inspection of conditions in the firebox can be made.

3. Open the fire door.

4. Examine the fire for evenness and thickness to determine whether or not the grates need shaking and which grates should be shaken. (Units P-6 and P-8 give information that will help the fireman to decide when to shake the grates.)

   NOTE: Fire and ash should be ten inches or less in depth and should be even on the grates.

   NOTE: Grates are installed in the firebox at a slight angle sloping toward the front. The fire should be level with the grates (Fig. 2).

5. Estimate the fire thickness by judging the distance between the top of the fire and the smoke-consumer holes (Fig. 2). (Refer to Unit P-2 for detailed inspection procedure.)

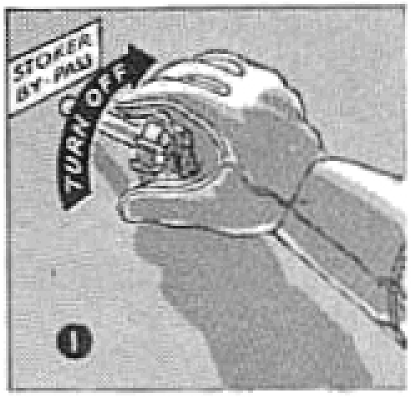
   NOTE: Smoke-consumer holes are approximately twenty inches from the grates.

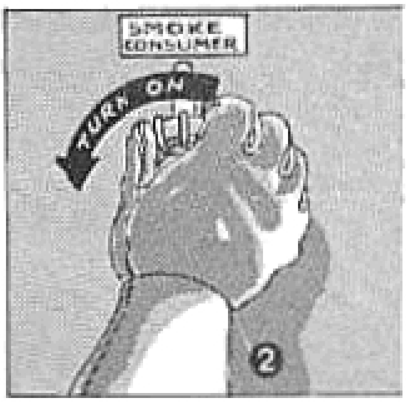
   Distance between grates and arch tubes at the throat sheet is fourteen inches.

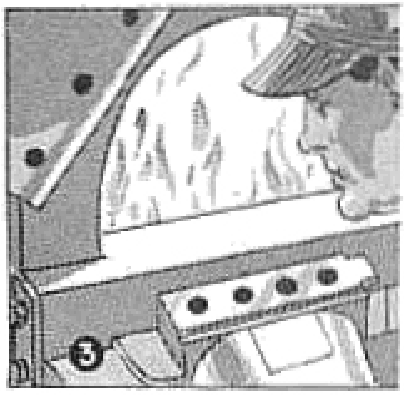
   Staybolts are four inches apart.

6. Decide which grates to shake, how much to shake them and when to shake them. The operation of the grates requires good judgment.

7. Organize the fire and get the boiler pressure up if necessary before shaking the grates.







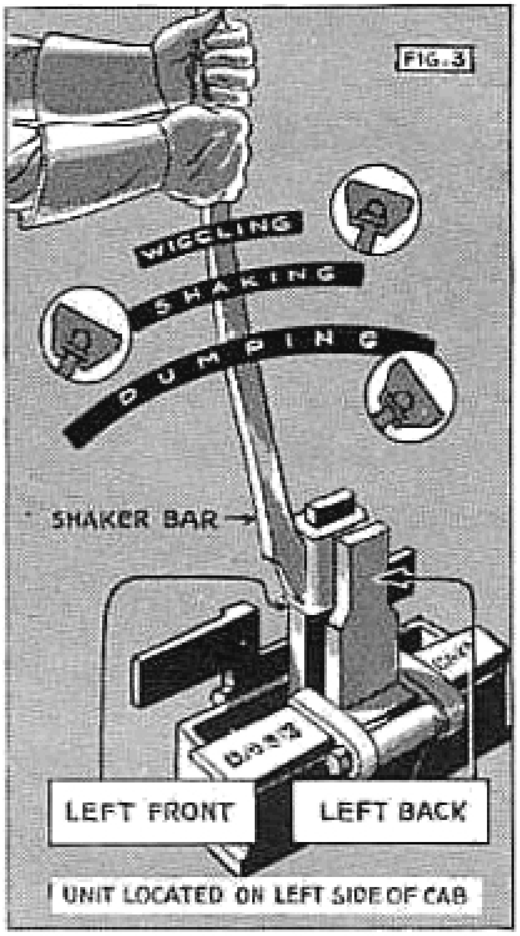


FIG. 3

8. Shake the grates. Move one section of the grates, or more than one section as required by the fire condition.

   NOTE: Suggested procedures for shaking the grates to correct different fire conditions are given in this unit on pages 92 to 95 under the following headings: (1) Operating grates to remove normal ash accumulations, (2) Operating grates when the fire is thin in the back or has "worked ahead," (3) Operating grates to eliminate banks or high spots, (4) Operating grates to remove clinkers.

9. Organize the fire and get the boiler pressure up, if necessary, before inspecting the fire.

10. Inspect the fire to see whether or not it is in good condition after shaking the grates.

OPERATING THE GRATES TO REMOVE NORMAL ASH ACCUMULATIONS

1. Place the shaker rod on the grate levers and move the front grates enough (Fig. 3) to correct any unsatisfactory condition revealed by the inspection. Refer to pages 88 and 89 for information about how much to shake the grates.

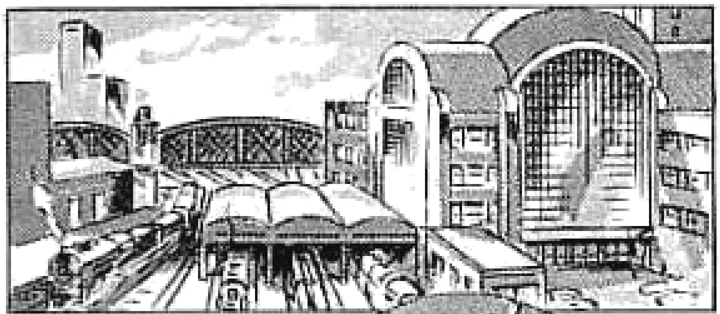
   CAUTION: Be sure that the keeper locks are up and that the shaker bar fits on the lever to avoid injury while operating the grates.

   a. It is desirable to move the front grates first to make sure that air is coming through the front portion of the fire.

   b. Control the fire depth and the draft through the fire bed by gently moving the grates often enough to remove the normal ash accumulation.

   c. DO NOT SHAKE THE GRATES AT TERMINALS EN ROUTE UNLESS ABSOLUTELY NECESSARY.

2. Shake the rear grates.



a. If it is necessary to shake the grates excessively to reduce the ash accumulation it may be desirable to wait a short time after shaking each section before shaking the next section so that the entire fire bed will not be disturbed at one time.

b. It may be desirable to hand fire light spots or holes if they develop while the grates are being shaken.

c. If conditions permit, the ash-pan flusher should be used immediately after shaking the grates. This will prevent fire and ashes from building up on the wings of the ash pan and thus avoid damage to the grates and shaker rods.

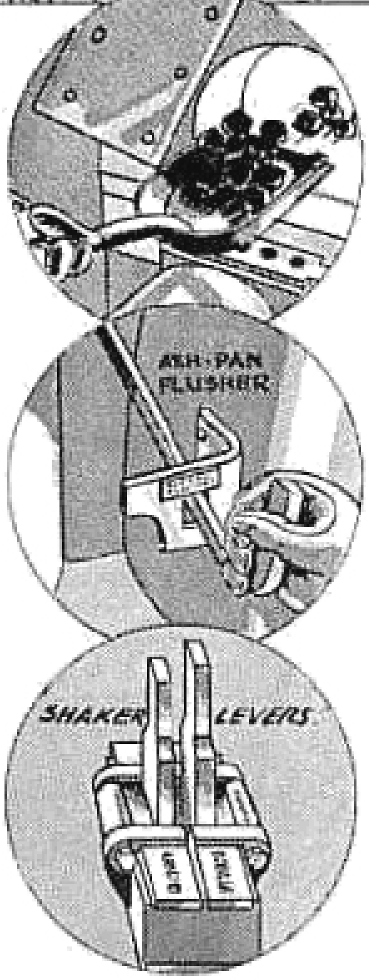
3. Restore the keepers to lock the grates in their flat position after the shaking operation is completed.

4. Shut off the smoke consumer.

5. Resume stoker operation.

NOTE: If the bad conditions were caused by an improper amount of coal or an uneven distribution of coal over the fire bed, make the necessary adjustments by changing the stoker speed or the jet pressures.

6. Examine the fire to make certain that it is in good condition.



OPERATING THE GRATES WHEN THE FIRE IS THIN IN THE BACK OR HAS "WORKED AHEAD"

1. Notify the engineman if a bad fire condition is found so that he can "ease off" or, if necessary, close the throttle while the fire is being repaired. This is done to decrease the pull through the thin area which causes an unbalanced draft.

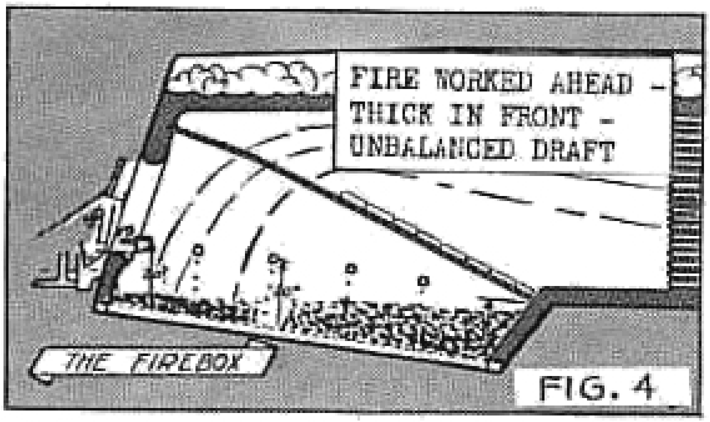


FIG. 4

2. Equalize the draft through the grate area, before attempting to build up the back of the fire, by placing the shaker rod on the front grate levers and by moving or rocking the grates gently under the thickest portion of the fire (Fig. 4).

   CAUTION: Be sure that the shaker bar fits on the lever and that the keeper locks are up (Fig. 3)

   NOTE: Shaking the grates violently disturbs the entire fire bed, fire is often shaken through the ash, and clinkers form on the grates.

3. Remove the shaker bar and restore the keeper locks to the locked position. This locks the grates in the flat position and avoids the burning of sections of the grate.

4. Shut off the smoke consumer. The smoke consumer tends to hinder the distribution of the coal and should be used only when needed.

5. Close the fire door and resume stoker operation.

   NOTE: When the stoker is not operating, the fire dies down and the boiler pressure drops.

OPERATING THE GRATES TO ELIMINATE BANKS OR HIGH SPOTS

1. Determine the cause of the bank while inspecting the fire.

2. Take immediate action to correct the distribution of the coal by adjusting the stoker jets.

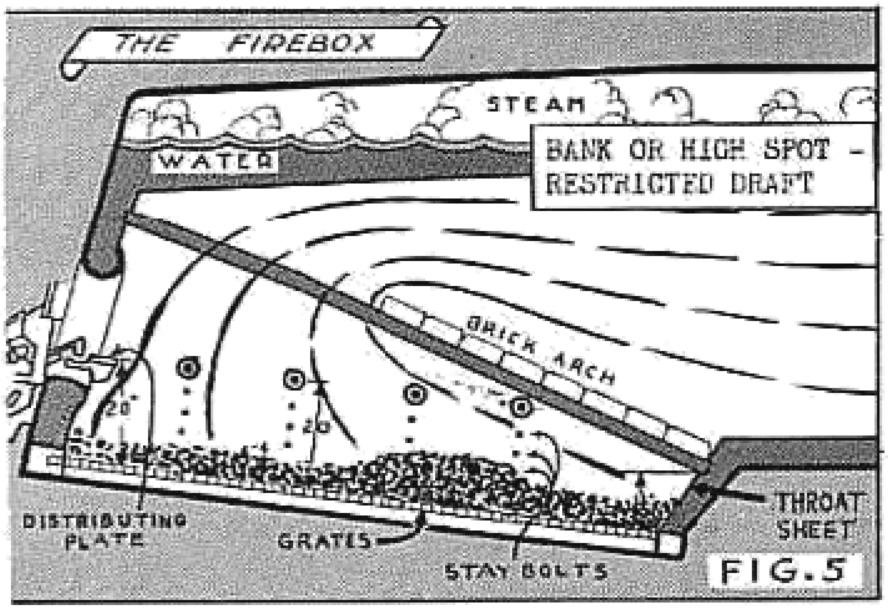


FIG.5

3. Determine the location and size of the bank (Fig. 5) and decide what movement of the grates is necessary to reduce the thickness of the bank and to restore the draft through that portion of the grate area covered by the bank.

4. Place the shaker rod on the grate lever that operates the section of grate under the bank. The keepers

(Fig. 3) are marked so that the fireman can readily see which section of the grate he is shaking.

5. Move the shaker lever forward and backward until the high spot or bank has been eliminated and the fire has the proper thickness.

   NOTE: Do not use the fire rake unless it is absolutely necessary. However, if the rake must be used, use it only to level off the bank, being careful not to tear the fire bed by digging into it with the rake. Refer to Unit I-6, Coal and Combustion.

OPERATING THE GRATES TO REMOVE CLINKERS

1. Determine the size and depth of the clinker while inspecting the fire (Fig. 6).

   NOTE: Frequent inspection of the fire will enable the fireman to detect clinkers before they affect the fire seriously. In general, the grates should be moved or "wiggled" often (not shaken) to insure free-flowing air through the grates and thus eliminate one of the chief causes of clinker formation.

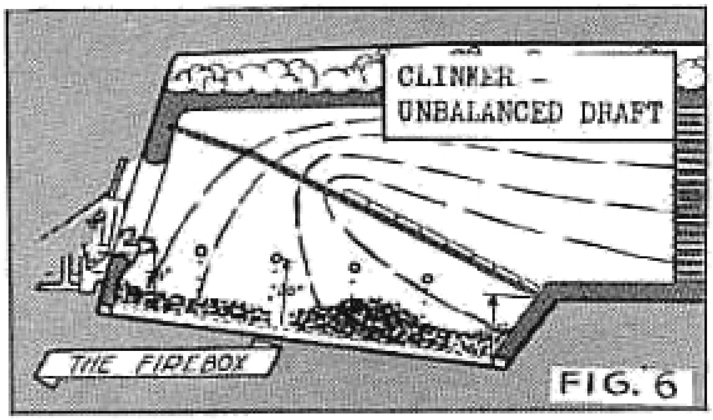


FIG. 6

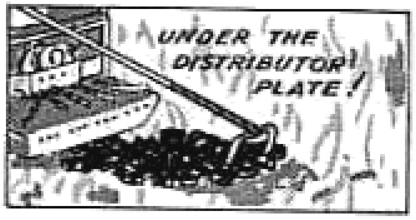
2. Open the grates under the clinker far enough to break the clinker. This may let enough air through the area to burn the clinker out. If this cannot be done, apply one or more of the following suggestions:

   a. Break the clinker up and work it through the grates.

   b. Take it out through the fire door, if possible.

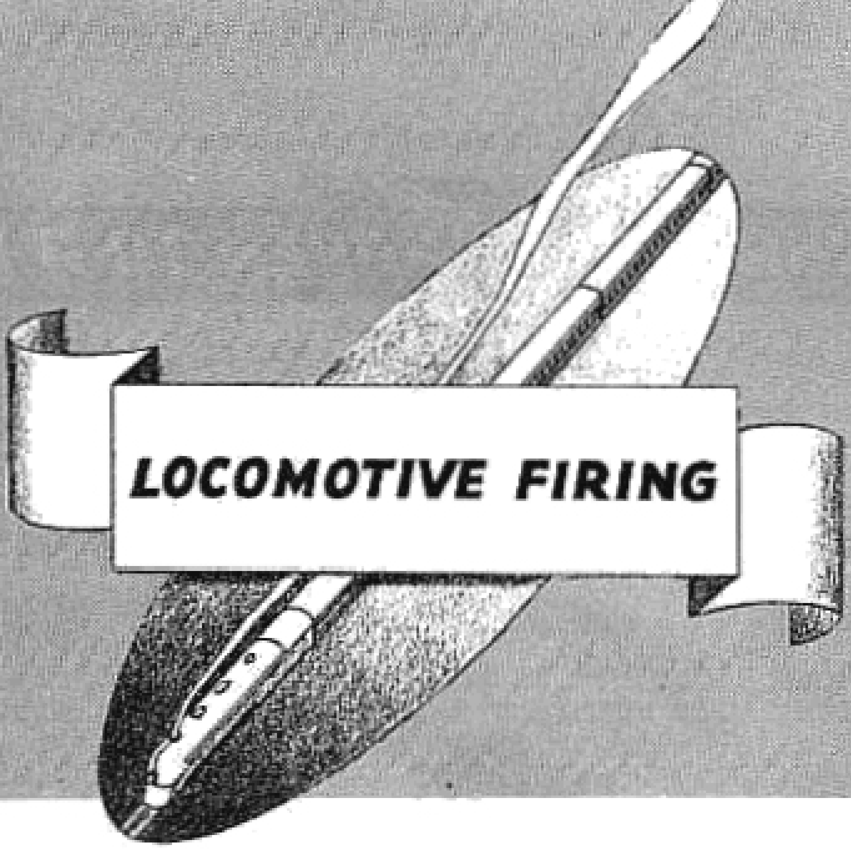
OUT THE FIRE DOOR!

   CAUTION: Handle the clinker carefully to avoid getting burned, and dispose of it in a way that will not injure anyone along the right of way.


UNDER THE DISTRIBUTOR PLATE!

c. Pull the clinker back under the distributing table or into the back corners with the fire rake.

NOTE: If it is necessary to open more than one section of the grates to break up a clinker, a short period of time should elapse after moving each section, and care should be taken to save as much fire as possible.



FIRE CONTROL

UNIT I-8
Pages 98-101

UNIT P-8
Pages 102-108

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WHAT CAN HAPPEN TO A FIRE

OBJECTIVES

1. To point out several things that may affect the fire while a locomotive is on a run.

2. To explain what the fireman can do to prevent trouble from developing when things do happen that will affect the fire.

INTRODUCTORY INFORMATION

The conditions described in this unit give the fireman some information that will enable him to anticipate bad fire conditions before they develop or to discover them immediately after they have developed. By knowing what can happen, the fireman is able to take steps to correct conditions before his fire is seriously affected.

THINGS THAT AFFECT THE FIRE

CUT-OFF AND THROTTLE CHANGES

If the cut-off is shortened or the throttle is eased off, less steam is required and there is a possibility of getting too much COAL in the firebox and too much WATER in the boiler unless the stoker speed, the stoker-jet pressure, and the water supply are regulated to decrease the supply of coal and water according to the reduced demand.

If the cut-off is lengthened, or if the throttle is widened, more steam is required and more COAL and WATER must be supplied. The stoker speed, the stoker-jet pressure, and the water supply should be increased accordingly.

The fireman will know when these changes take place if:

a. There is close cooperation between the fireman and the engineman (Fig. 1).

b. He observes the conditions under which the locomotive is being worked and anticipates a need for more or less steam.

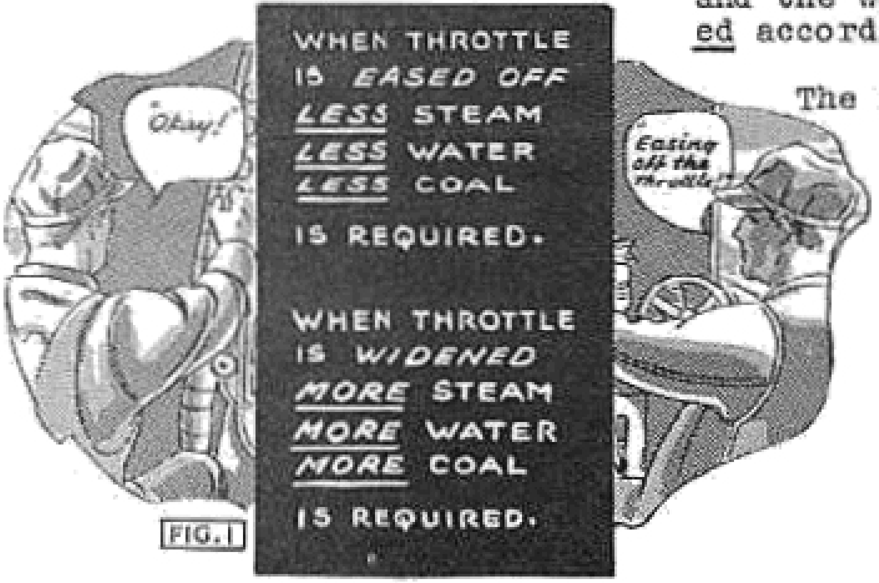

Okay!
WHEN THROTTLE IS EASED OFF LESS STEAM LESS WATER LESS COAL IS REQUIRED.
WHEN THROTTLE IS WIDENED MORE STEAM MORE WATER MORE COAL IS REQUIRED.
Easing off the throttle!

FIG. 1

c. The steam pressure gage is watched for a rise or fall in pressure.

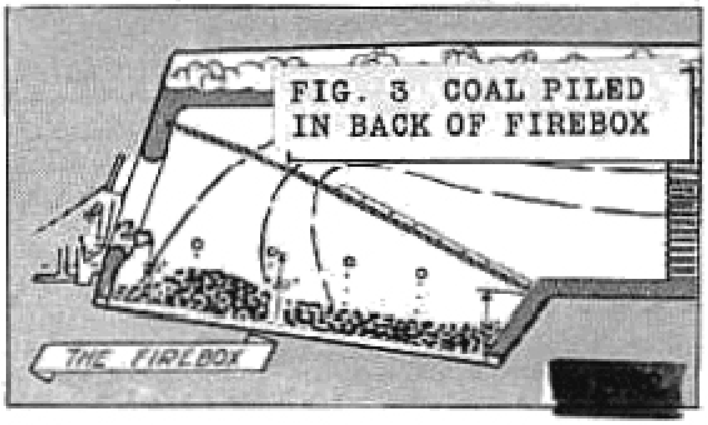


FIG. 3 COAL PILED IN BACK OF FIREBOX

CHANGES IN KINDS OF COAL

If the COAL goes from lump to slack, the jet pressures should be DECREASED; otherwise a bank may form under the ARCH (Fig. 2).

If the COAL goes from slack to lump, the jet pressures should be INCREASED; otherwise a bank may form in the back of the firebox (Fig. 3).

If the COAL goes from dry to wet, or from wet to dry, the jet pressures may require adjustment.

The fireman will know when these changes take place if:

a. He watches the coal being supplied to the stoker.

b. He watches the coal being delivered to the distributing table.

c. He inspects the fire frequently to see that the coal is being evenly distributed.

IMPROPER JET SETTING

If the stoker jets are IMPROPERLY SET, banks will form in the firebox (Figs. 2 and 3). The fire should be built up properly at the terminal and then careful attention should be given to the jet pressures to maintain an even distribution of coal after leaving the terminal and after the stoker is started.

The fireman can detect improper jet pressures if:

a. He watches the grade of coal in the tender and at the distributing table to detect changes in the kind of coal being fired.

b. He watches the amount of coal being delivered by the stoker.

c. He inspects the fire frequently and watches for banks and low spots.

d. He watches the boiler-pressure

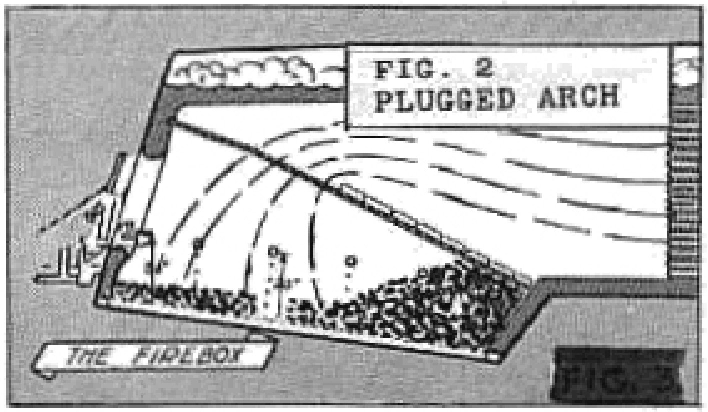


FIG. 2 PLUGGED ARCH

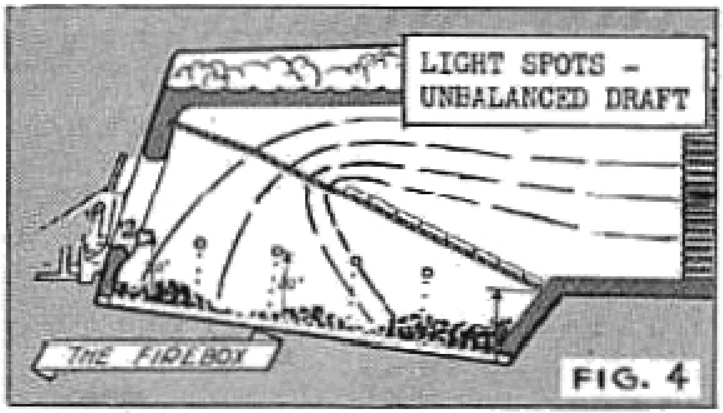


FIG. 4

gage for an increase or decrease in pressure.

IMPROPER SUPPLY OF COAL TO FIREBOX

Too little coal will let the fire become light in some portions of the firebox and may result in an unbalanced draft through the fire bed (Fig. 4). This may cause an excessive carry-over of cinders and unburned coal which may plug the netting. A thin fire has a tendency to creep off the back grates. The steam pressure will drop if the fire is too light for the conditions under which the locomotive is working.

Too much coal will cause a heavy fire which may result in an accumulation of ash and cinders. Excessive smoke and a waste of coal result from feeding coal to a fire faster than it can be burned.

The fireman can supply the proper amount of coal to the firebox if:

a. He inspects the fire frequently and increases or decreases the supply of coal by regulating the stoker speed as required.

b. He watches the steam pressure and observes the conditions under which the locomotive is being worked and then controls the coal supply accordingly.

c. He knows the "run" and can plan ahead to supply coal according to steam demands.

d. He has the cooperation of the engineman who notifies him beforehard of changes in running conditions that will affect the demand for steam.

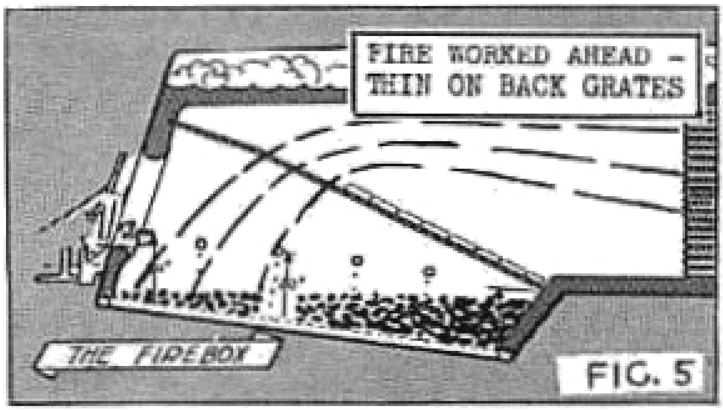


FIG. 5

FIRE WORKS AHEAD ON THE GRATES

There is a tendency for the fire to creep ahead on the grates (Fig. 5) when there is a change in speed or when a vibration is set up by the engine riding rigid at high speed in short-running cut-off. This causes the fire to become light on the back grates.

The fireman can avoid this by:

a. Inspecting the fire for this

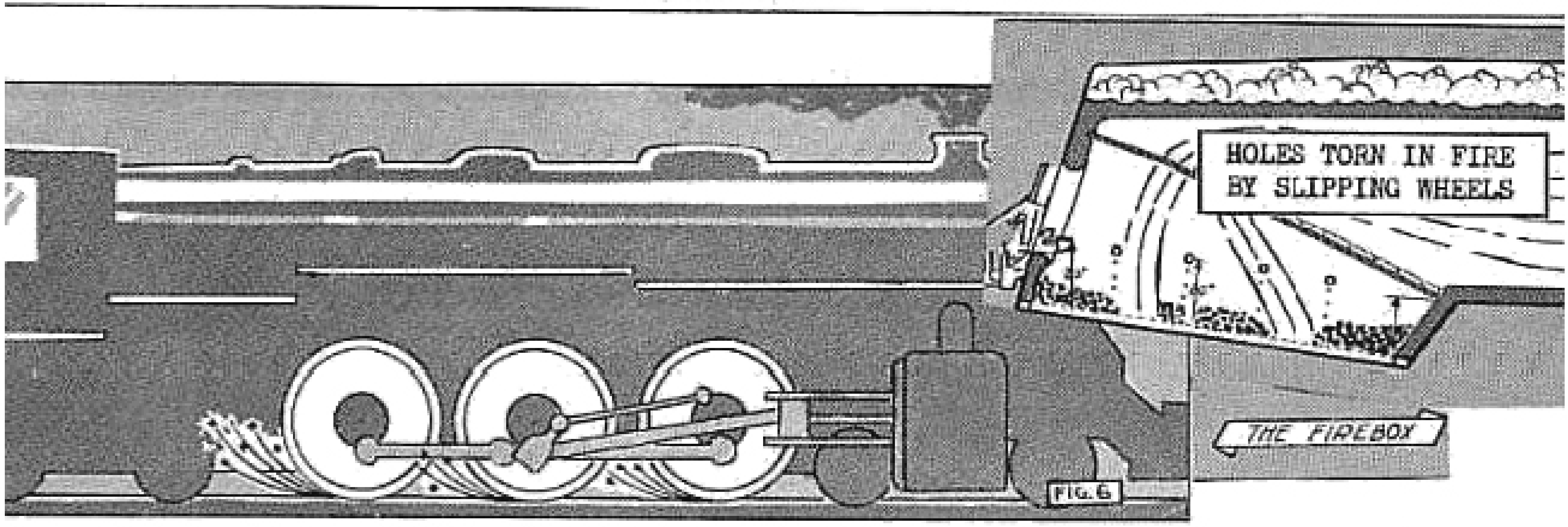

HOLES TORN IN FIRE BY SLIPPING WHEELS
THE FIREBOX

FIG. 6

condition when the locomotive is riding rough or vibrating, and when a change in speed takes place.

b. Notifying the engineman if the fire condition is serious in order that he may ease off or, if necessary, close the throttle to decrease the pull on the fire.

c. Adjusting the jets to maintain an even fire.

d. Shaking the front grates, if necessary, to equalize the draft through the fire before building up the light spots with the scoop.

e. Using the scoop, if necessary, to assist in building the fire up along the back.

SLIPPING OF LOCOMOTIVE DRIVE WHEELS

Holes may be torn in the fire if the wheels of the locomotive slip (Fig. 6). The fire should be inspected after severe slipping. Coal should be added by hand with the scoop if holes occur.

SELECTED REFERENCES

Examinations for Firemen and Hostlers	New York Central System
Instructions for the Preparation and Maintenance of Locomotive Fires	New York Central System
Traveling Engineers' Examination Book	Railway Fuel and Traveling Engineers' Association
Locomotive Cyclopedia	Simmons, Boardman Pub. Co.

HOW TO CORRECT BAD FIRE CONDITIONS

OBJECTIVES

1. To emphasize the fact that bad fire conditions can be avoided by following proper firing procedures.
2. To explain how to correct common defects in the fire.
3. To explain how to correct unusual conditions in the firebox.

INTRODUCTORY INFORMATION

Bad fire conditions may be avoided if the fireman inspects his fire often and follows the rules for firing as outlined in Unit P-6, How to Fire Different Kinds of Coal. However, in spite of proper care and all precautions, unsatisfactory fire conditions arise, and it is necessary, therefore, for the fireman to be able to recognize such conditions and correct them.

EQUIPMENT REQUIRED

The equipment provided should comply with local instructions.

Lanterns (Red and White)
Flags (Red and White)
Alligator Wrench
Monkey Wrench
Scoop Shovel
Fire Rake
Packing Hook
Packing Spud
Oil Can and Waste
Drinking Water Container

Wire Torch
Shaker Bar
Grease Gun
Slide Hook
Coal Pick
Torpedoes
Jet Hook
Fusees

PROCEDURE

HOW TO CORRECT BANKS IN THE BACK OF THE FIREBOX

1. Examine the fire carefully to determine the size and location of the bank. Refer to Unit P-2, How to Inspect the Fire, for complete information on fire inspection.
2. Determine the cause of the bank (Fig. 1).

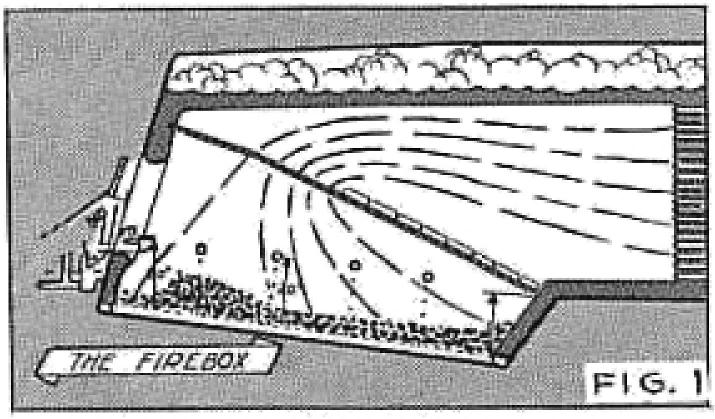


FIG. 1

NOTE: The bank may be caused by improper jet pressure, improper adjustment of the vanes, the formation of a clinker, or by crowding the fire.

3. Correct the bank by doing any or all of the following:

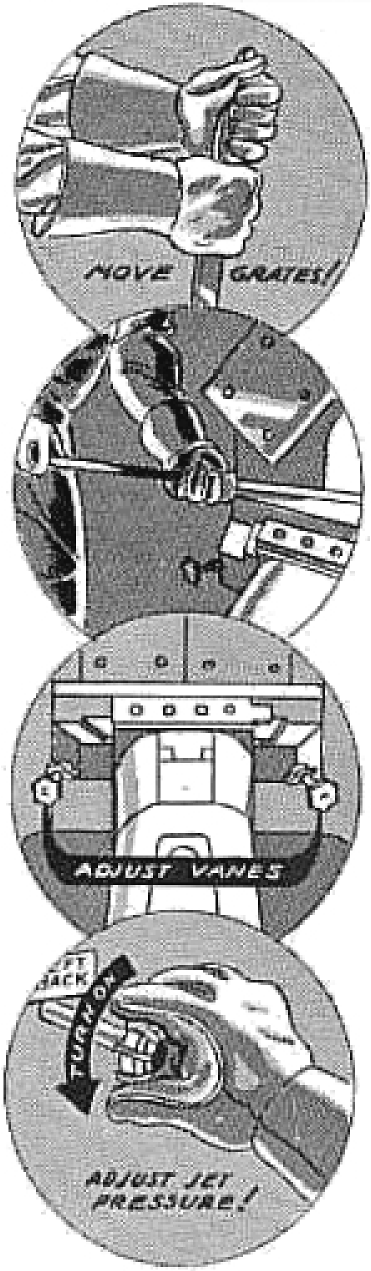
   a. Place the shaker rod on the shaker lever and move the grates under the bank lightly to equalize the flow of air through the fire, and thus prevent the formation of clinkers.

      NOTE: The fire rake may be used to level off the bank if care is taken not to disturb the fire bed.

   b. Readjust the vanes (on stokers so equipped by loosening the lock nuts on the vane-control screws and by turning the screws to the right to reduce the amount of coal delivered to the back corners.

   c. Increase the steam pressure to the right back and left back distributor jets by opening the jet valves slightly so that the coal will be distributed evenly over the entire fire bed. Refer to Unit P-4 for detailed information on distributor-jet adjustments.

4. Examine the fire often to check the results of these adjustments, thus making certain that coal is being evenly distributed.


MOVE GRATES!
ADJUST VANES
ADJUST JET PRESSURE!

HOW TO CORRECT BANKS IN THE FRONT OF THE FIREBOX

1. Examine the fire carefully to determine the size and location of the bank (Fig. 2) as a basis for deciding upon the corrective measures to be taken.

2. Move the grates under the bank.

3. Decrease the pressure on the right-front and left-front dis-

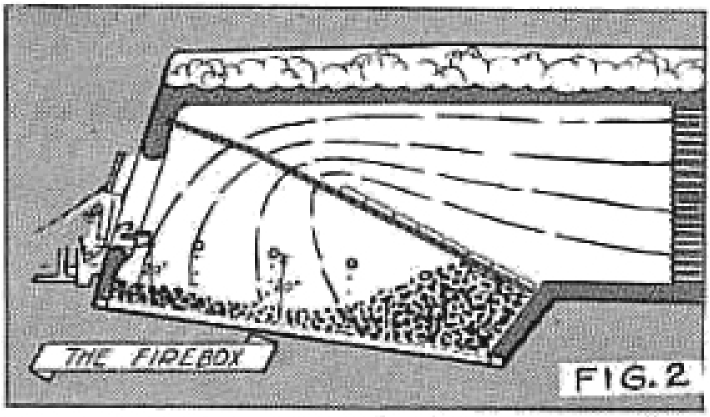
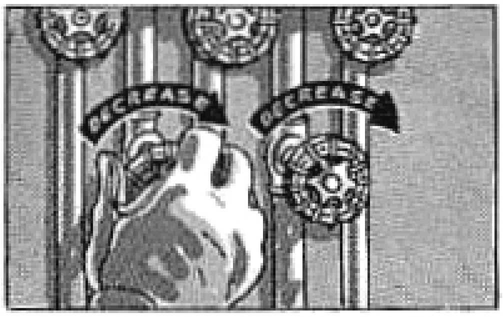


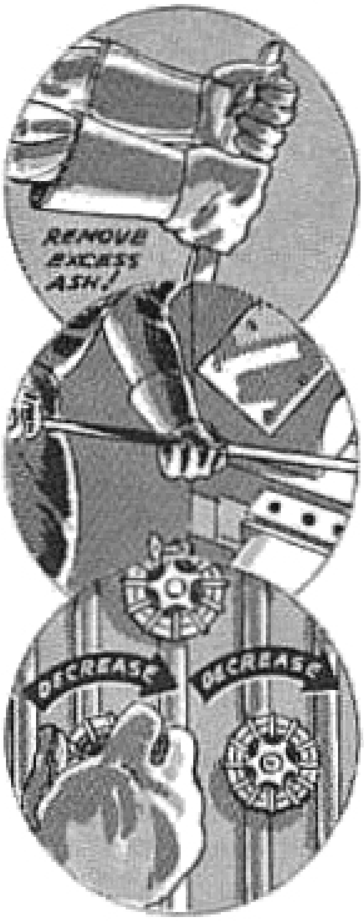
FIG. 2



tributor jets by turning the jet valves clockwise.

4. Inspect the fire frequently to make certain that the coal is being evenly distributed.

   NOTE: When wet coal is being fired, the jet pressures are sometimes increased so high that the wet coal is blown under the brick arch (Fig. 2). When this happens the arch may be plugged.



HOW TO CORRECT A PLUGGED ARCH

1. Move the front grates until the excess ash has been removed.

2. Level off the fire with the fire rake.

   NOTE: Use the rake with care to avoid mixing the unburned coal with the ashes.

3. Decrease the jet pressures by turning the right-front and left-front jet valves clockwise to decrease the amount of coal supplied to the front of the firebox.

4. Examine the fire frequently and make certain that the bad condition has been corrected and that the coal is being evenly distributed.

HOW TO CORRECT LIGHT SPOTS UNDER THE DISTRIBUTING TABLE

1. Examine the fire carefully to determine the size and location of the light spot (Fig. 3).

   NOTE: A light spot under the distributing table is one of the most difficult conditions to detect because it is not possible to see directly under the table. If the boiler pressure drops and the fire directly ahead of the distributing table has an especially bright appearance, it is reasonably safe to assume that there is a light spot

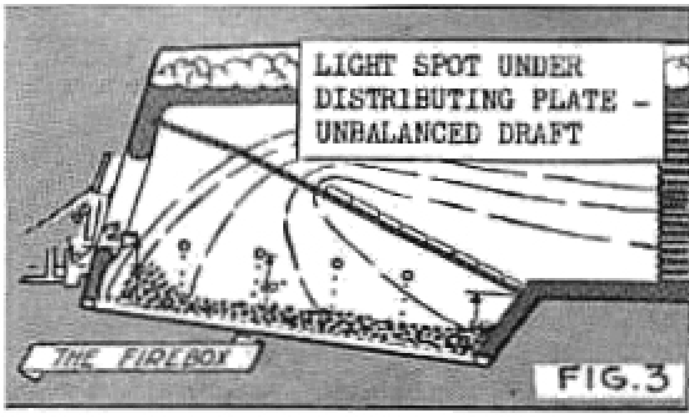
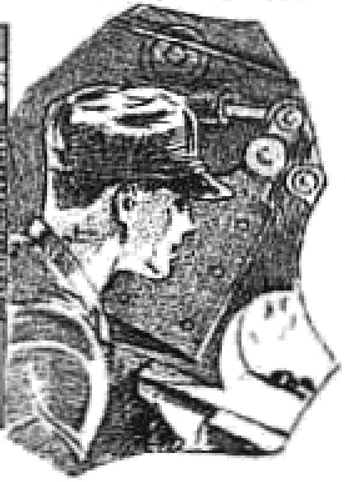


FIG.3



or a bare spot under the distributing table.

2. Hand fire the light spots with the scoop, or invert the scoop and place it over the top of the distributing table and close the fire door. This will deflect the coal down below the table.

   CAUTION: If the inverted-scoop method is used, close the fire door to prevent the coal from being blown out of the door.

3. Examine the fire often to check for proper depth and even distribution.

HOW TO CORRECT LIGHT SPOTS ON THE BACK GRATES

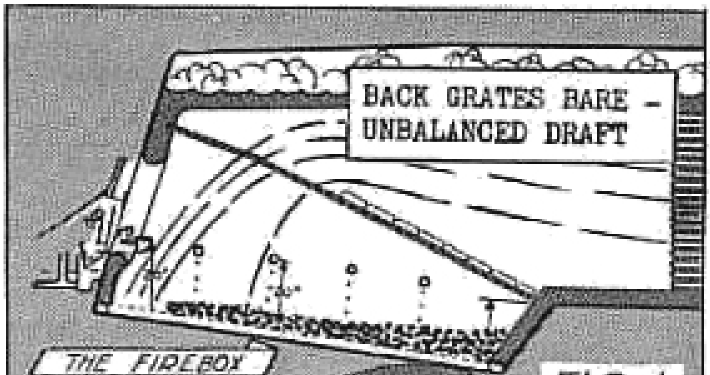

BACK GRATES BARE - UNBALANCED DRAFT
THE FIREBOX

FIG. 4

1. Check the fire bed carefully for light spots or bare spots, and note the size and location of them.

   NOTE: Bare spots (Fig. 4) occur often on the back grates because the vibration of the locomotive causes the fire to creep ahead on the grates which are on an angle.

2. Call the attention of the engineman to the fire condition so that he may "ease off" or, if necessary, close the throttle so that the pull on the fire will be decreased, thereby eliminating the possibility of plugging the netting while the fire is being built up.

3. Hand fire the bare spots with the scoop.

4. Adjust the stoker jets to supply more coal to the back portion by increasing or decreasing the pressure on the right-back and left-back jets. (See Unit P-4 for information on stoker jet adjustments.)

HOW TO CORRECT FIRE DEPTH (Fire Too Deep)

1. Inspect the fire carefully to determine the depth by estimating the distance between the top of the fire and the distributing table and smoke-consumer holes (Fig. 5). On the BK and HT stoker,

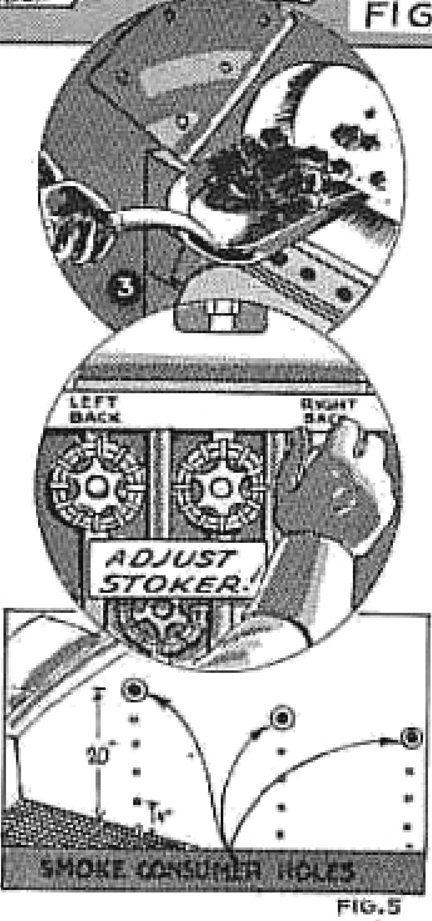


FIG. 5

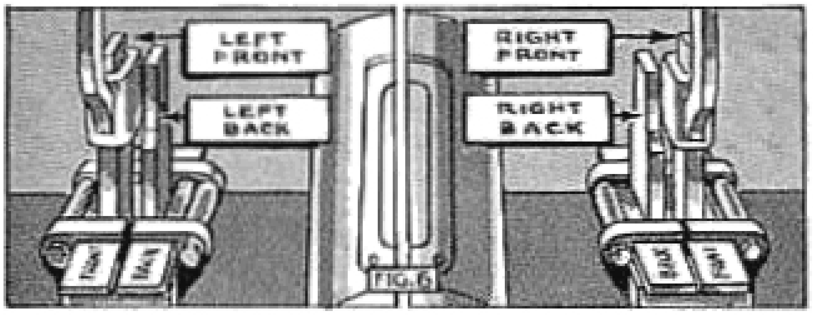
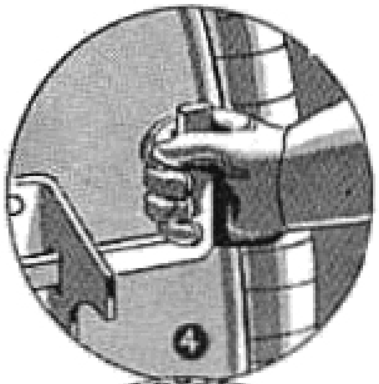


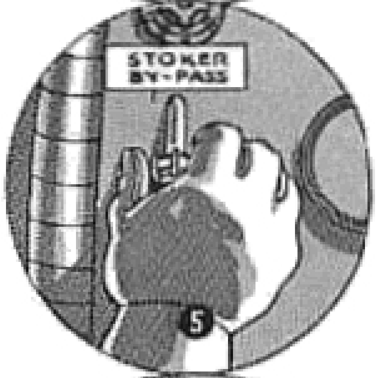
FIG. 6

both the distributing table and the combustion tubes, or smoke-consumer holes, are approximately twenty inches from the top of the grates. The fire should be ten inches or less in depth.

2. Reduce the fire depth by placing the shaker bar on the front grate levers (Fig. 6) and by rocking the grates carefully. For information on shaking grates, refer to Unit P-7, How to Shake Grates.

   NOTE: Do not rock the grates so violently that the entire fire bed will be disturbed.





3. Place the shaker bar on the rear grate lever and rock the rear grates carefully until the proper depth has been attained. It may be well to wait a short time after shaking the front grates before shaking the rear grates and thus avoid disturbing the whole fire at one time.

4. Flush the ash pan after shaking the grates, if conditions permit, to prevent damage to the grates or shaker rods by the fire and ash building up on the wings of the ash pan. For complete information on the use of the ash-pan flusher, refer to Unit P-9, How to Use the Ash-pan Flusher.

5. Reduce the speed of the stoker by turning the stoker-throttle valve clockwise so that the supply of coal will be decreased. The fuel should be fed to the fire just fast enough to maintain the correct boiler pressure. Excess fuel is wasted, produces smoke, and may cause clinkers.

6. Observe the amount of coal being delivered to the distributing table by opening the peepholes in the top of the elevator pipe or discharge box.

7. Watch the boiler pressure.

HOW TO CORRECT A CLINKERED FIRE

1. Inspect the fire to determine the size and location of the

clinker (Fig. 7). The size of the clinker may be determined by the size of the bank or dead spot and also by the area of the fire which moves when the grates are rocked.

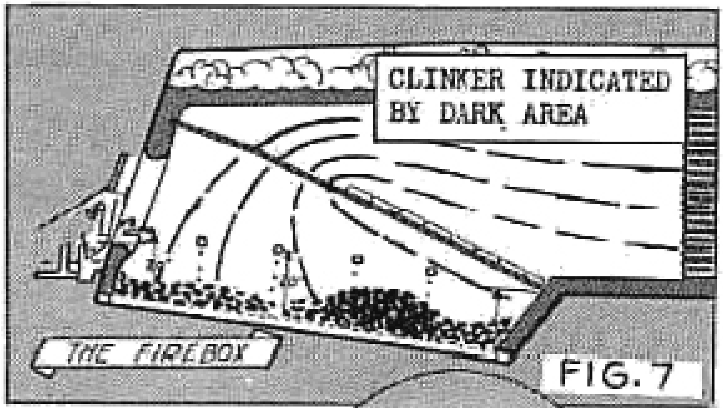


FIG. 7

2. Place the shaker rod on the grate lever and open the grates under the clinker enough to break the clinker. This will allow air to pass through the clinkered area. If this does not eliminate the clinker, apply the following suggestions as a last resort:

    a. Pull the clinker to the back of the firebox, under the distributing table, with a fire rake. The fire rake should be used only to pull the clinker back under the distributing table to break it up.

    b. Knock the clinker through the grates if possible.

    NOTE: If the clinker cannot be broken up small enough so that it will go through the grates, it should be removed through the fire door.

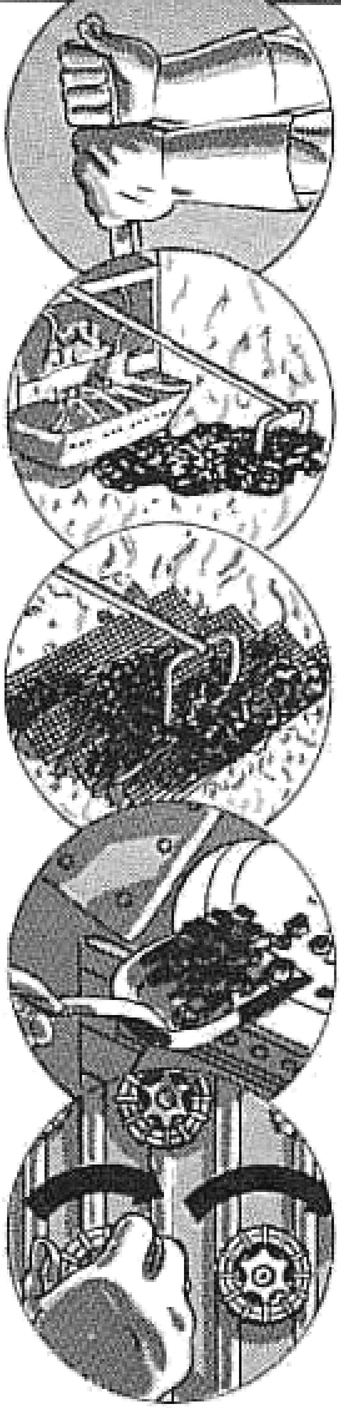
    CAUTION: Use care when handling hot clinkers. The squirt hose may be used to cool the clinkers after removing them through the firebox.

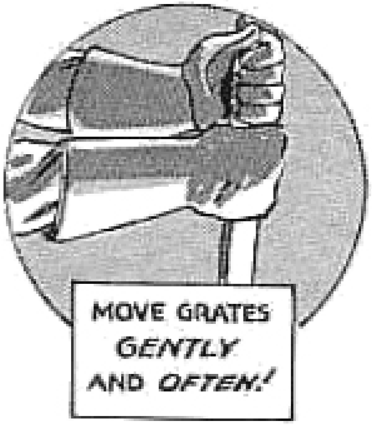
3. Hand fire the light spots with a scoop.

4. Readjust the stoker jets to equalize the distribution of the coal so that banks will not form. Banks develop into clinkers. For information on stoker adjustments, refer to Unit P-4, How to Adjust Stoker Jets.

5. Examine the fire frequently. Frequent inspections are the fireman's best insurance against serious troubles with his fire. A bad condition can usually be corrected by making a minor adjustment if it is discovered soon enough.

NOTE: If the coal being fired tends to form





clinkers, pay particular attention to the following standard firing rules:

a. Avoid overcrowding the fire.

b. Do not allow banks to form.

c. Keep a balanced draft through all portions of the fire by maintaining an even fire.

d. Move the grates often and gently to keep the fire light and clean.

e. Avoid the use of the fire rake except in emergencies.

SUGGESTIONS ON FIRING TO AVOID DAMAGE TO THE FIREBOX AND TUBES

1. The fire should be heaviest at the sides and the back corners of the firebox to make certain that holes do not develop at these points. Holes here would cause cold air to strike the side sheets or back sheets of the firebox.

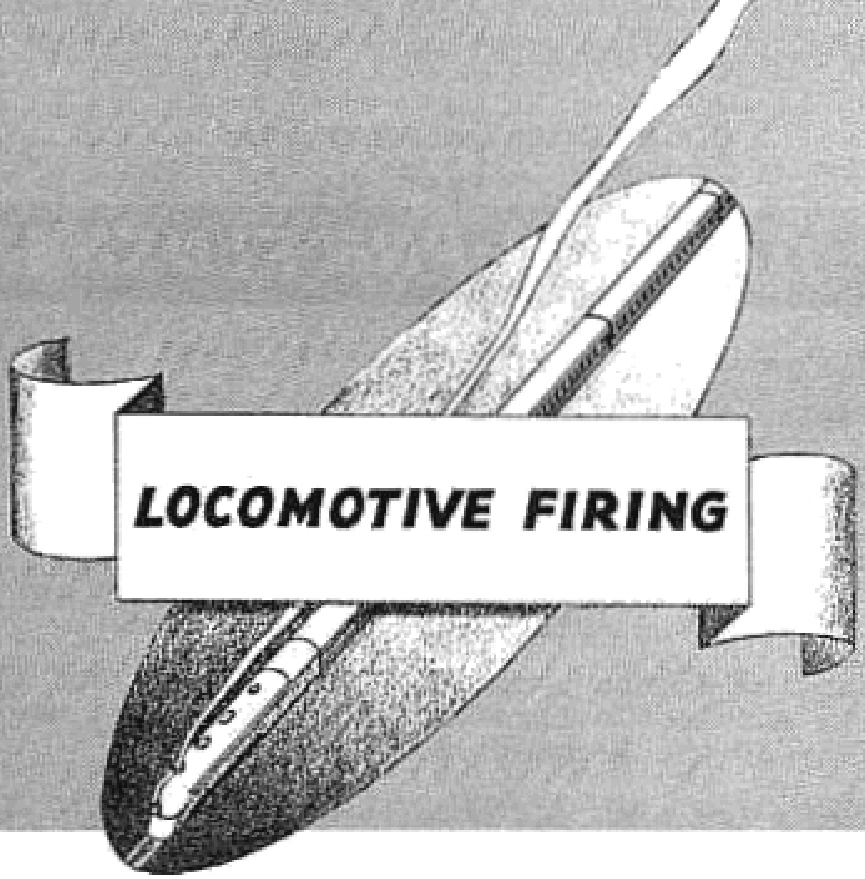
2. Avoid too much coal in front of the fire door as this causes burned distributing tables and clinkered fires.

3. Maintain an even steam pressure, and pump an even water level to avoid too rapid expansion or contraction of firebox sheets and boiler flues.

4. Watch the water gages closely to avoid low water. This condition may cause a burned crown sheet.

5. Avoid foaming by using the manual blowdown as per local instructions.

6. Avoid holes, light spots, or banks in the fire bed, as these cause an uneven draft through the firebox.



THE ASH-PAN FLUSHER
AND
THE COAL PUSHER

UNIT I-9
Pages 110-112

UNIT P-9
Pages 113-116

UNIVERSITY OF THE STATE OF NEW YORK
STATE EDUCATION DEPARTMENT
BUREAU of INDUSTRIAL AND
TECHNICAL EDUCATION

THE ASH-PAN FLUSHER

OBJECTIVES

1. To describe the locomotive ash pan.
2. To explain the purpose of the ash-pan flusher.
3. To describe the ash-pan flusher.

INTRODUCTORY INFORMATION

An understanding of the purpose of the ash pan and the ash-pan flusher will enable the fireman to make the best use of these important parts of the locomotive.

PURPOSE OF THE ASH PAN

The ash pan receives the ashes shaken from the grates and carries them until they can be conveniently dumped so that hot coals will not start fires along the right of way.

It is important that hot cinders or burning coals deposited in the ash pan be kept away from the grates and grate rods to avoid overheating them. Excessive heat in the ash pan may burn or warp the grate sections, grate carrier bars, and shaker rods.

DESCRIPTION OF ASH PANS

Ash pans are made to fit into the limited space available beneath the firebox of a locomotive. The ash pan consists of the hopper which carries the ashes and the upper section which fits

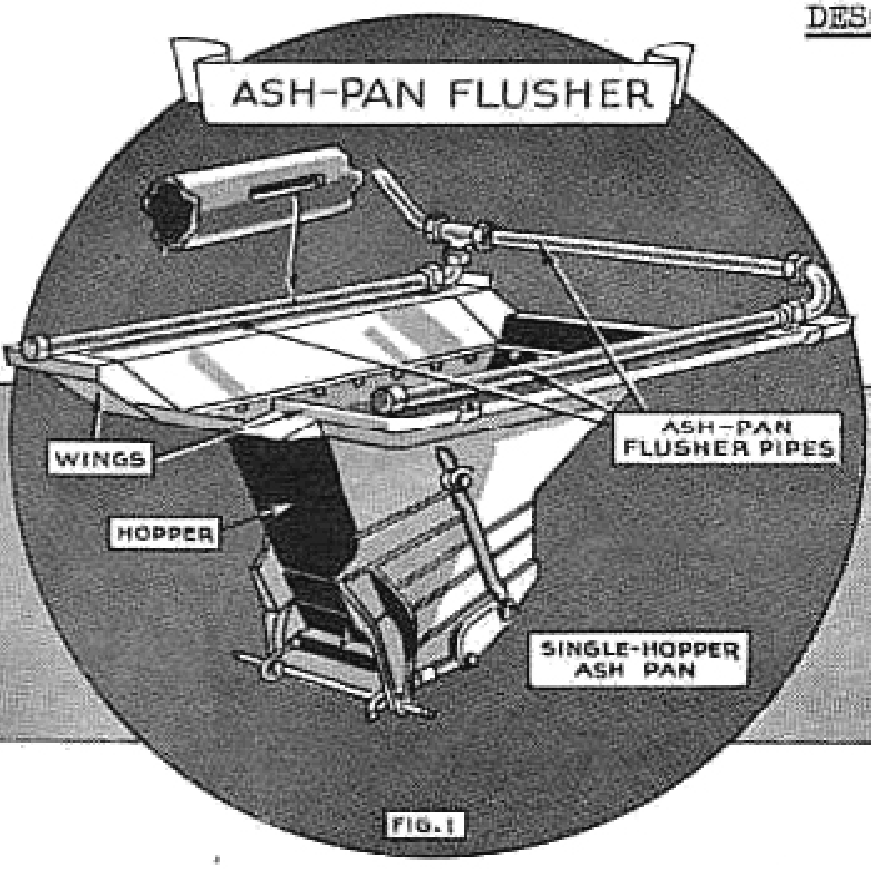


FIG. 1

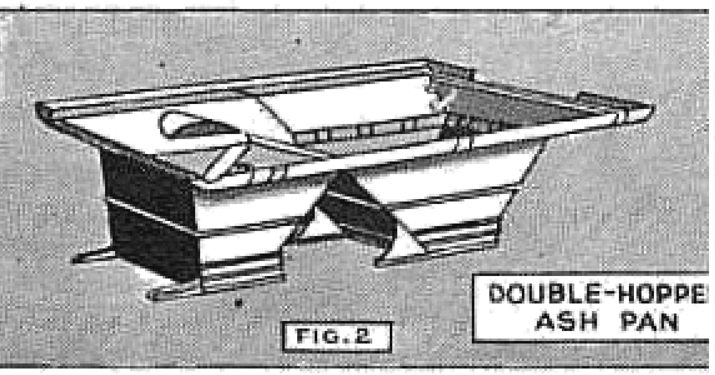


FIG. 2

the bottom of the firebox and conveys the ashes to the hopper. Ash pans may have either a single hopper (Fig. 1) or a double hopper (Fig. 2). Each hopper is provided with either a swinging door (Fig. 1) or a sliding door (Fig. 2).

The design of the hopper is important because it must be rigid enough to keep the door in alignment so that it will close tightly. If the ash-pan doors do not close tightly, hot cinders and sparks may fall out and cause serious fires along the right of way.

THE ASH-PAN FLUSHER

The ash-pan flusher (Fig. 3) consists of a control rod in the cab and a control valve in the boiler leg connected to flushing pipes along the sides of the wings of the ash pan. These pipes have spray slots at intervals along them. Through these slots water can be sprayed at an angle against the ash-pan wings to wash the ashes into the ash pan.

There is a cap on the end of each flush pipe so that sediment from the boiler can be cleaned out. Obstructed flush pipes should be reported.

WHAT THE ASH PAN FLUSHER DOES

The ash-pan flusher does three important things:

1. It flushes the ashes from the sloping wings of the ash pan into the hopper. An excessive amount of ashes in the ash pan or an accumulation of ashes on the sloping wings may interfere with the free flow of air through the grates and into the firebox. Such obstruction either reduces the draft through the grates or causes an unbalanced draft.
2. It extinguishes burning cinders or coals and prevents them from continuing to burn in the ash pan. This eliminates the possibility of starting fires along the right of way and reduces the possibility of burned or warped grates and grate-control rods.
3. It provides a means of thawing frozen ashes in the hopper before they are dumped.

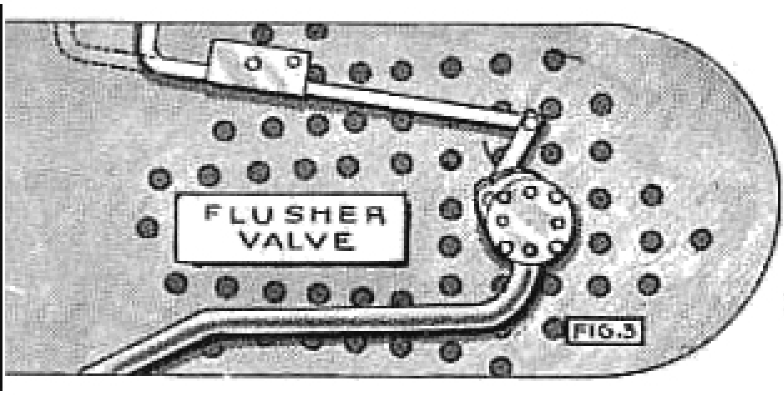


FIG.3

WHEN TO USE THE ASH-PAN FLUSHER

If conditions permit, the ash-pan flusher should be used immediately after shaking the grates to prevent damage to the grates or shaker rods by the fire building up on the wings of the ash pan.

In freezing weather, thaw the frozen ashes by applying the ash-pan flusher before the ashes are to be dumped en route.

WHERE THE ASH PAN SHOULD BE DUMPED

Dump ashes only according to local instructions.

SELECTED REFERENCES

Examinations for Firemen and Hostlers	New York Central System
Instructions for the Preparation and Maintenance of Locomotive Fires	New York Central System
Locomotive Cyclopedia	Simmons, Boardman Pub. Co.

How to use the ASH-PAN FLUSHER and the COAL PUSHER

OBJECTIVES

1. To tell how to use the ash-pan flusher.
2. To explain the function of the mechanical coal pusher.
3. To explain how to use the coal pusher.

INTRODUCTORY INFORMATION

The procedures for using the ash-pan flusher and the coal pusher are given in separate sections in this unit. The operation of these devices is not complicated but it is important that they be operated correctly.

EQUIPMENT REQUIRED

Valve oil for coal-pusher lubricator

ASH-PAN FLUSHER

The ash-pan flusher is used to remove ashes from the wings of the ash pan and to cool hot coals or cinders.

After considerable ash has been shaken out, there is likely to be an accumulation of ashes on the wings of the ash pan which may prevent a sufficient volume of air from coming through the grates. Excess ash on the wings of the ash pan may cause burned or warped grates and shaker rods.

The ash-pan flusher (Fig. 1) should be used immediately after the grates are shaken, if conditions permit.

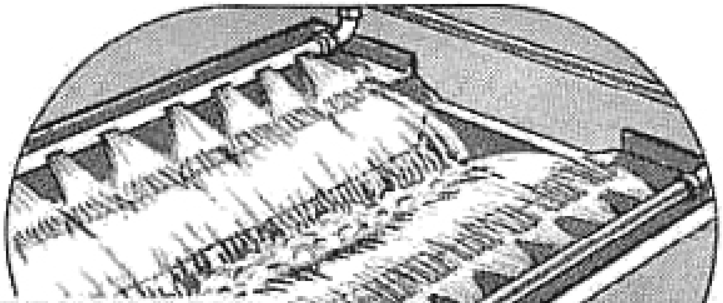


FIG. 1

PROCEDURE

HOW TO OPERATE THE ASH-PAN FLUSHER

1. Flush the ash pan by opening the ash-pan flusher valve (Fig. 2) after shaking all grates or whenever

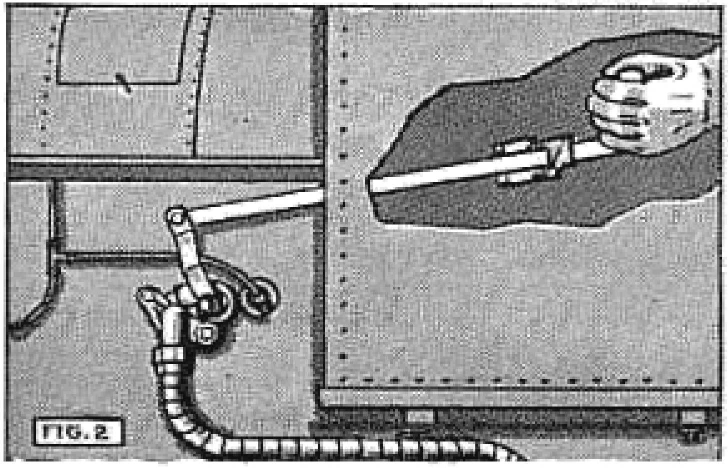


FIG. 2

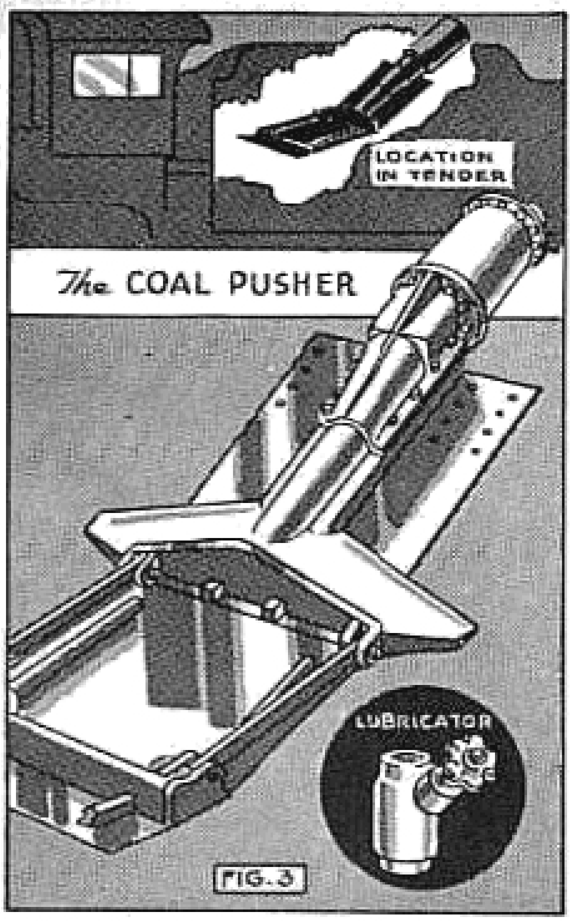


FIG. 3

there is a possibility of an accumulation of ashes on the wings of the ash pan. The ash pan, however, does not need to be flushed each time the grates are moved.

2. Flush the ash pan in freezing weather before arriving at any place en route where the ash pan is to be dumped so that ashes will not be frozen and therefore be difficult to remove from the hopper.

THE COAL PUSHER

The mechanical coal pusher (Fig 3) is used to move the coal forward in the tender when it does not feed into the opening to the tender-conveyor trough of the stoker.

The coal pusher consists of a steam cylinder which operates a T-shaped main pushing member located on the rear slope sheet of the tender. It is operated by a quick-action valve in the steam line under the tender. The valve is controlled by a handle located on the coal gate of the tender (Fig. 6).

Lubrication is a very important factor in securing satisfactory service from the coal pusher. Valve oil is used as a lubricant and is injected into the steam line by a special lubricator (Fig. 3).

HOW TO LUBRICATE THE COAL PUSHER

The best time to use the lubricator is after the pusher has made one or two strokes so that the piping and cylinder mechanisms will be hot.

1. Shut off the main steam valve (Fig. 5).

2. Close tightly the small valves above and below the lubricator.

3. Unscrew the lubricator filler plug, pour in the valve oil, and replace the plug (Fig. 3).

4. Open the small valves above and below the lubricator.

5. Reopen the main steam valve.

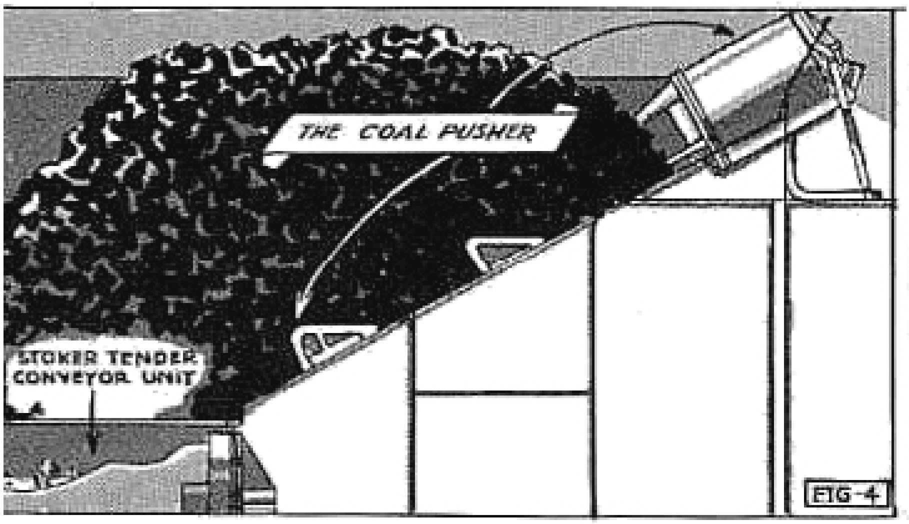


FIG-4

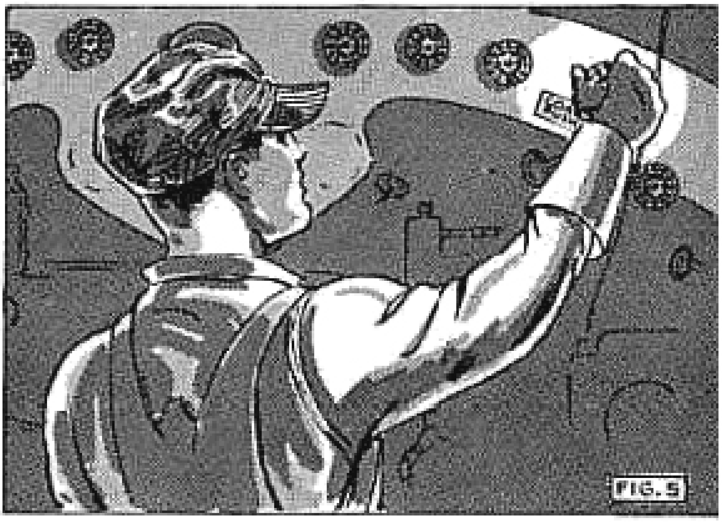


FIG. 5

NOTE: One lubricator full of oil per trip is usually sufficient.

HOW TO OPERATE THE MECHANICAL COAL PUSHER

1. Watch the coal in the tender to make certain that the tender-conveyor screw is receiving a sufficient amount of coal at all times (Fig. 4).

   NOTE: The coal pusher should not be used when the coal is against the front of the tender as there is a possibility of demaging the gates.

2. Open the main steam valve (Fig. 5) located on the turret.

   This valve is used to shut off the steam to the operating valve when the coal pusher is not in use.

3. Push the operating lever down as far as it will go and hold it in this position until the pusher completes the up stroke. The operating lever is located on the tender (Fig. 6).

   An automatic steam-cushioning arrangement stops the piston at the end of both the up and down stroke of the pusher.

   The up stroke loosens the coal around the pusher crossheads.

4. Release the operating valve-handle. A spring automatically returns the valve to the down-

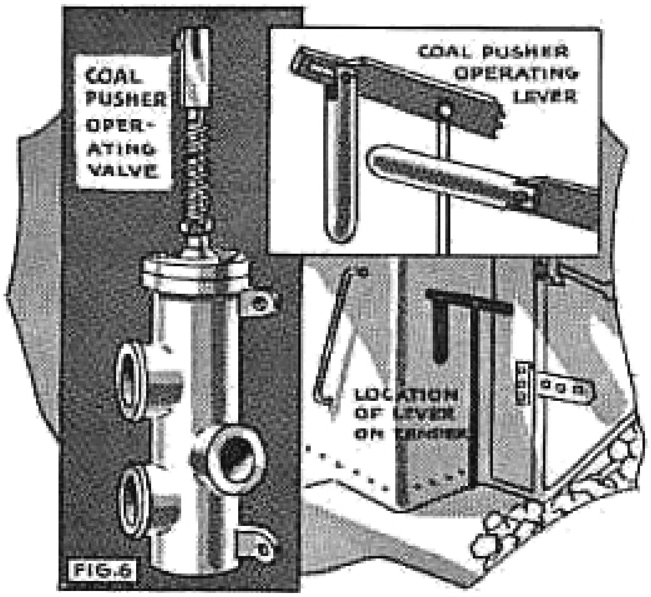
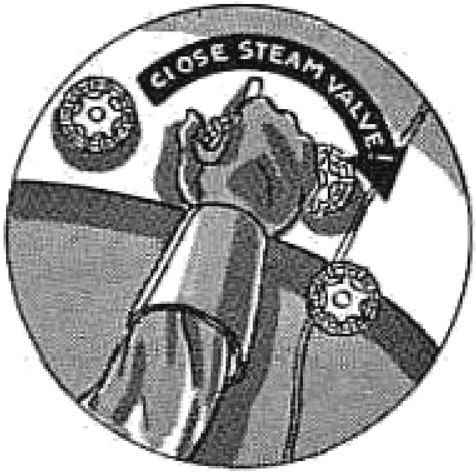

COAL PUSHER OPERATING VALVE
COAL PUSHER OPERATING LEVER
LOCATION OF LEVER ON TENDER

FIG. 6


CLOSE STEAM VALVE!

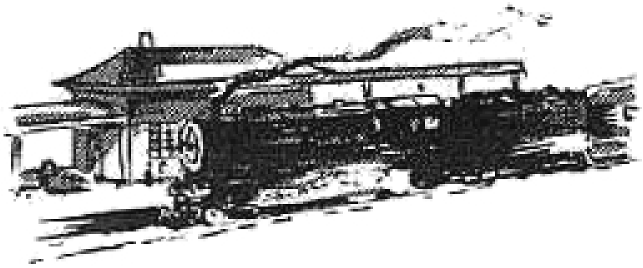
stroke position (Fig. 6) which causes the pusher to return to the down position, pushing the coal forward in the tender.

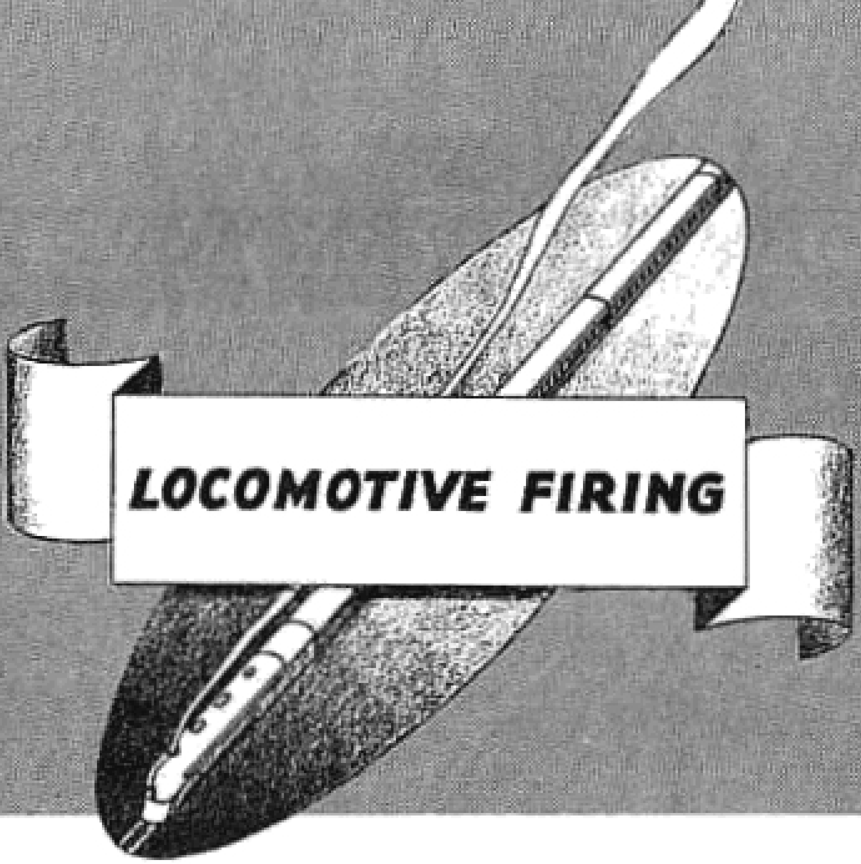
The coal pusher is left in the down position when it is not in operation.

5. Close the steam valve. This valve should be closed at all times when the pusher is not being used, unless local instructions direct otherwise.

NOTE: If the valve is open when the pusher is not in use, the pressure will hold the drain valves closed, thus causing condensation in the piping and the pusher cylinder. Escaping steam may obscure signals.

6. Operate the pusher three or four times at the end of each trip and before taking coal. This helps to keep the pusher in good working order.





SLUDGE AND FOAM CONTROL

UNIT I-10
Pages 118-121

UNIT P-10
Pages 122-124

UNIVERSITY OF THE STATE OF NEW YORK
STATE EDUCATION DEPARTMENT
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BOILER BLOWDOWN SYSTEMS

OBJECTIVES

1. To explain the need for blowing down the boiler of a locomotive.
2. To tell when the manual blowdown is used.
3. To describe an automatic blowdown system.

INTRODUCTORY INFORMATION

For maximum efficiency a locomotive must have dry steam. This is obtained by maintaining a good fire and by using good judgment in keeping the water in the boiler at the correct level. It is also important to keep the water in the boiler in good condition by keeping the dissolved solids at a minimum.

The amount of impurities in the boiler water must be controlled to avoid foaming, and it is for this purpose that locomotives are equipped with blowdown systems. Both automatic and manual systems are available.

FOAMING AND ITS EFFECTS

Foaming is caused by an excessive amount of impurities in the water. Impurities present in water remain in the boiler when the water is evaporated into steam and thus become more and more concentrated if they are not removed.

Impurities in boiler water are in two forms: soluble elements that dissolve in the water, and solids in the form of mud or sludge

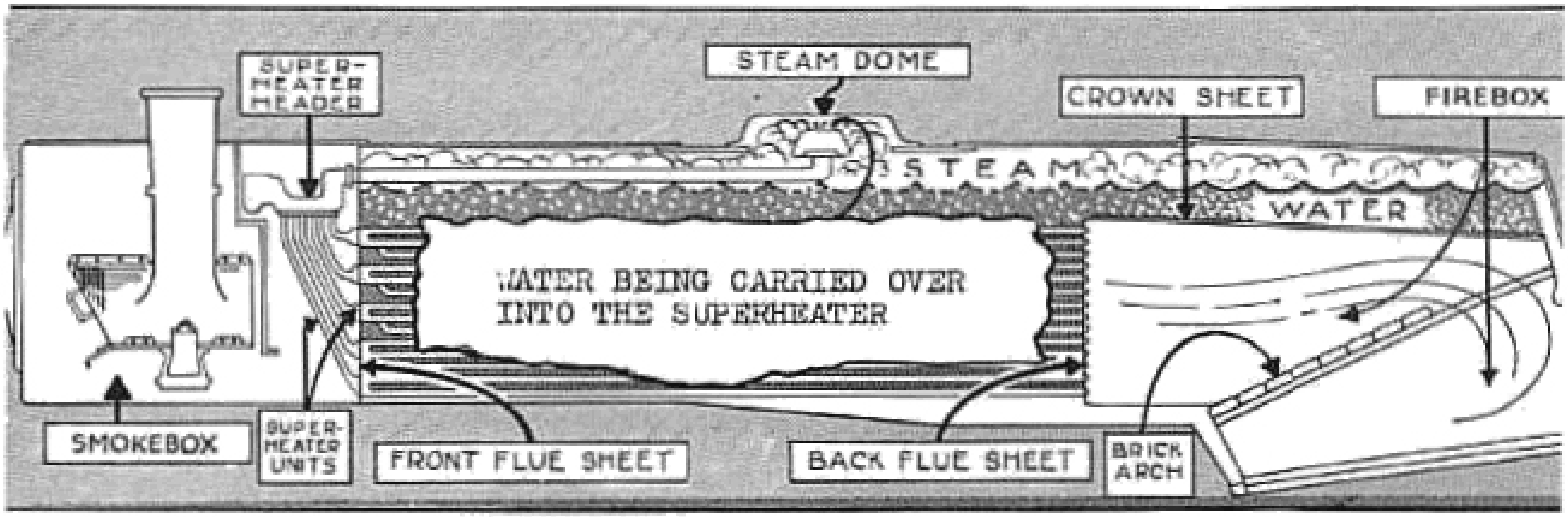


FIG. 1

which do not dissolve. The dissolved elements are discovered by analyzing the water. When these elements are known, the harmful effects in the boiler can be reduced by treating the water with chemicals. The undissolved material will settle to the lowest part of the boiler and can be drained off with the automatic and manual boiler blowdown systems.

The fireman has no control over the problem of getting good water for use in the boiler, but when he must use water that has a tendency to foam there are two important reasons why he must watch the water level in the boiler closely. The first reason is that foaming water causes the locomotive to "work water," and has the same effect as too much water in the boiler as shown in Fig. 1. This makes the superheater ineffective because the heat that should superheat the steam, is used to make steam out of the water carried over with the steam. In addition, the impurities in the foaming water are carried over into the superheater and may form a scale on the surface of the units which shortens the useful life of the superheater. The second reason is that the lubrication of valves and cylinders is destroyed by the water, a condition which may result in a loss of power and may cause scored or broken parts.

Foaming makes it difficult to get a true indication of the water level in a locomotive boiler, because it increases the bubbling action that takes place when water boils. When water boils, bubbles of steam are produced at the heating surfaces and rise through the water (Fig. 1). When the water is boiling violently, the bubbles of steam form so rapidly that the volume of water in the boiler is increased. Water under this condition is called light water. When the bubbling action is taking place in a boiler the water glasses and gage cocks will indicate a higher water level when the throttle is open than they will when it is closed. A high water level is indicated when the throttle is open and a large quantity of steam is being used because the pressure on the water is reduced and the water bubbles freely. The true water level is indicated when the throttle is closed because the increased steam pressure on the water causes it to become "solid." The engine crew must take this condition into consideration when watching the water level in the boiler.

Foaming increases the tendency of boiling water to form bubbles and to become light. Thus, foaming water may give a false reading, especially when the throttle is wide open. There is a danger that the water level will fall below the top of the crown sheet, causing it to overheat. When water in the boiler is foaming, the throttle must be shut off gradually to show the true level of the water, and particular care must be taken to make certain that the water level does not get too low.

In addition, foaming, like high water, contributes to conditions which make for a hard steaming locomotive. It has a tendency to increase the draft and thereby disturb the fire bed. When the locomotive works water, it is good practice for the engineman to ease off on the throttle and open the cylinder cocks. Always remember that foaming and high water DESTROY LUBRICATION.

The manual blowdown should be used according to local instructions.

PREVENTION OF FOAMING

The tendency of water to foam is reduced by eliminating the impurities, sludge, and mud from the boiler by equipping the locomotive with a boiler blowdown device. This may consist of a manually operated valve (Fig. 2), or an automatic continuous blowdown system (Fig. 3), or both.

THE MANUAL BLOWDOWN

THE MANUAL BLOWDOWN consists of a valve in the base of the boiler leg (Fig. 2) which can be opened from the cab by the fireman or the engineman.

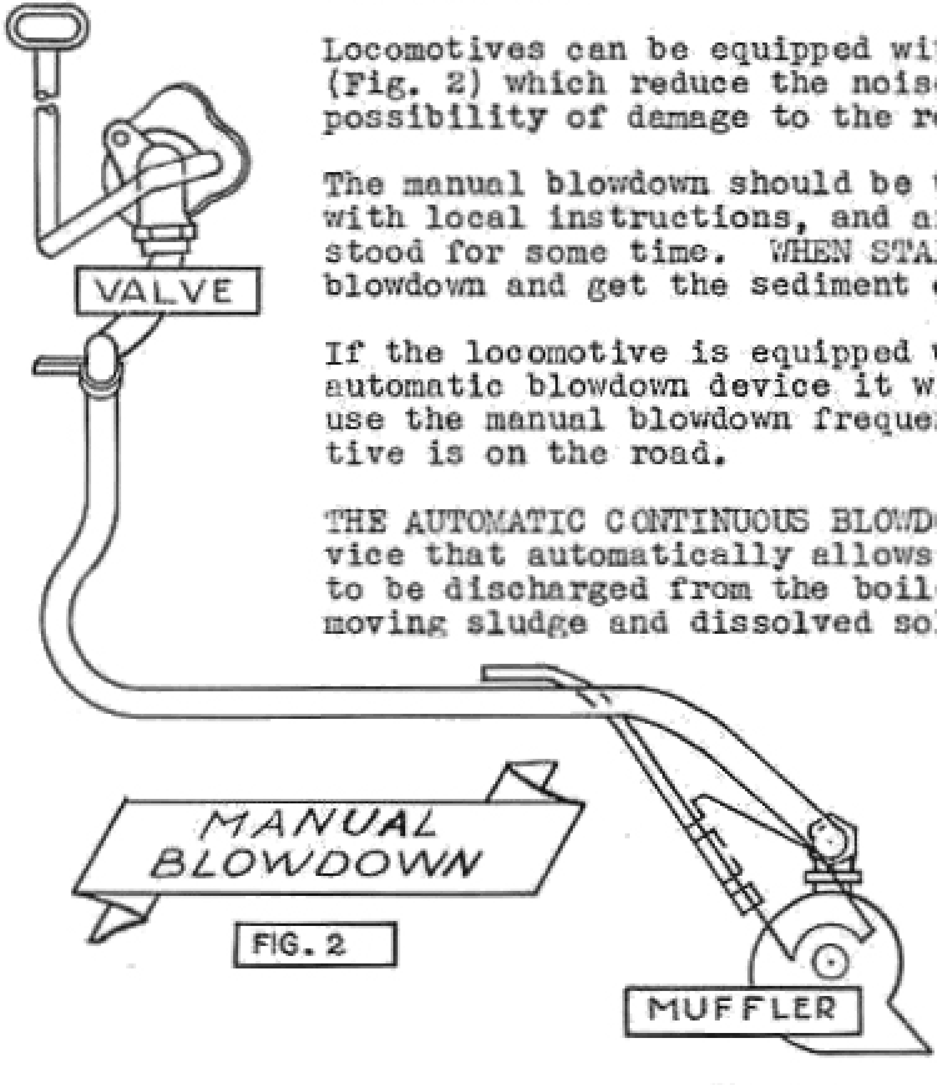


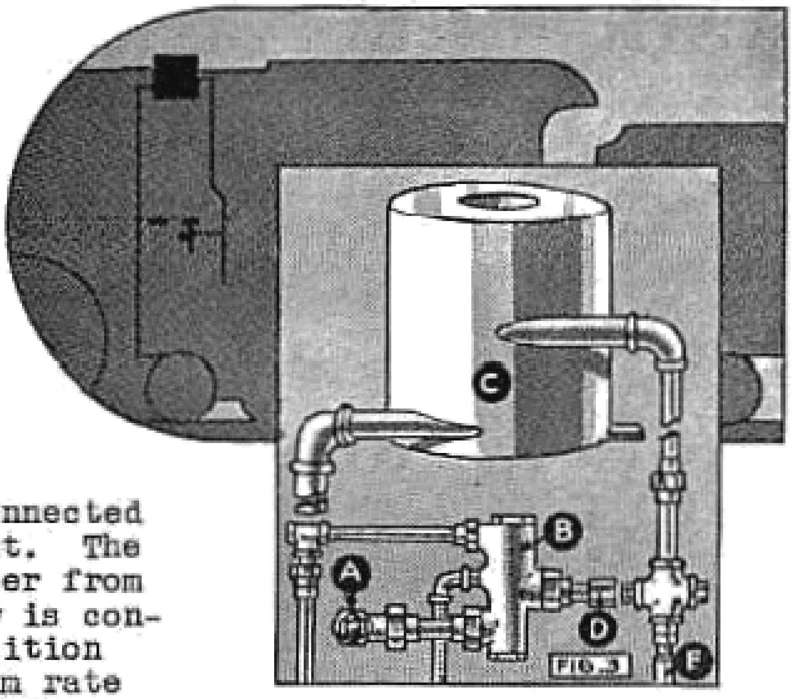
FIG. 2

Locomotives can be equipped with blow-off mufflers (Fig. 2) which reduce the noise and eliminate the possibility of damage to the roadbed.

The manual blowdown should be used often in accordance with local instructions, and after the locomotive has stood for some time. WHEN STARTING, open the manual blowdown and get the sediment out before it circulates.

If the locomotive is equipped with a well-regulated automatic blowdown device it will not be necessary to use the manual blowdown frequently while the locomotive is on the road.

THE AUTOMATIC CONTINUOUS BLOWDOWN (Fig. 3) is a device that automatically allows a small amount of water to be discharged from the boiler. By continuously removing sludge and dissolved solids at approximately the same rate at which they are added with the feed water, the automatic blowdown controls the concentration of impurities in the boiler water, thus preventing foaming and avoiding waste of water through excessive blowing.



It is not necessary for the fireman to know the details of the automatic blowdown, but a brief description is given here so that he will know the essential parts and their location on the locomotive. A typical automatic blowdown system consists of three main units with the necessary piping and connections. The angle valve (Fig. 3-A) is tapped into the boiler leg to draw off sludge and impurities in the water. The automatic blowdown valve (Fig. 3-B) is connected to the angle valve and the steam chest. The separator (Fig. 3-C) receives the water from the blowdown valve. The rate of flow is controlled at the steam chest by the position of the throttle valve, and the maximum rate of flow is restricted by an orifice (Fig. 3-D) placed between the blowdown valve and the separator. The connection to the steam chest is so made that the blowdown is in operation when the locomotive throttle valve is opened. Some automatic blowdowns are operated from the water-pump steam line and operate only when the water pump is working.

To test the device on locomotives equipped with the type controlled by water pumps, it is necessary to open the pump throttle sufficiently to register at least fifty pounds discharge pressure on the water-pump gage and then observe the bottom of the separator drain pipe (Fig. 3-E). If a discharge of water comes from the drain pipe, the blowdown is in working order. On a locomotive on which the automatic blowdown is controlled by the throttle, it is necessary to open the main throttle and make the same observations as previously stated.

SELECTED REFERENCES

Examinations for Firemen and Hostlers	New York Central System
Instructions for the Preparation and Maintenance of Locomotive Fires	New York Central System
Traveling Engineers' Examination Book	Railway Fuel and Traveling Engineers' Association
Locomotive Cyclopedia	Simmons, Boardman Pub. Co.

Pamphlets prepared by the manufacturers of automatic blowdown systems used on locomotives

HOW TO USE THE MANUAL BLOWDOWN

OBJECTIVES

1. To emphasize the importance of blowing down the locomotive in accordance with local instructions.

2. To explain how to use the manual blowdown.

3. To explain how to test the automatic blowdown.

INTRODUCTORY INFORMATION

Variations in the amount of impurities in the water of different localities and the differences in local operating conditions make it necessary to prepare local instructions for using the manual blowdown on locomotives. These instructions are prepared to assist the fireman in avoiding foaming of the boiler water by giving him information upon which to base his judgment.

Foaming in a boiler is caused by the concentration of impurities in the water. The purpose of the blowdown, whether automatic or manual, is to get rid of enough of the impurities to prevent foaming.

Priming is caused by carrying water too high in the boiler so that when the throttle is opened water passes over with steam in the form of spray (Fig. 1).

When the engine is working water, either because of foaming or because of high water in the boiler, the reading of the pyrometer gage will fluctuate or drop.

The bad effects from foaming and priming are similar.

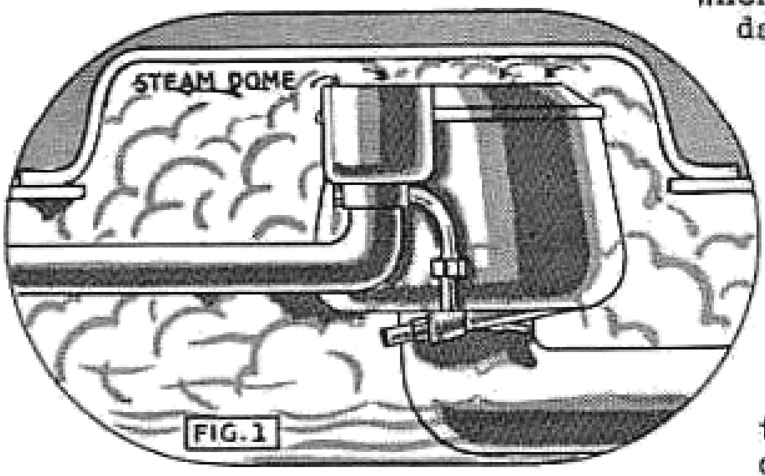


FIG.1

When the water foams badly, there is danger of knocking out cylinder heads, of cutting valves, and the danger of stalling on grades because the engine cannot be worked to its full capacity.

When a locomotive works water, there is danger of breaking cylinder packing rings, of knocking out cylinder heads, of breaking bolts in the steam chest, and the danger of cutting valves.

These dangers can be avoided by

following the steps and observing the suggestions presented under the procedure part of this unit.

PROCEDURE

WHAT TO DO IN CASE OF FOAMING

1. Notify the engineman of the condition. He may ease off on the throttle and may open the cylinder cocks to relieve the water from the cylinders.

2. Allow the boiler to cool off a little.

3. Increase the supply of water to the boiler, if necessary, to prevent the water from getting too low. Refer to Unit P-5, How to Pump the Boiler.

4. Use the manual blowdown (Fig. 2) when conditions permit, to get some of the bad water out of the boiler, thereby making room for clean water. Refer to page 124 for instructions.

   CAUTION: Make certain that there is sufficient water in the boiler before using the manual blowdown.

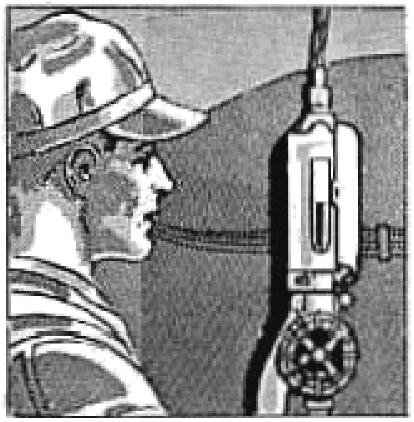
   CAUTION: Make certain that no one is near enough to be injured when the blowdown valve is opened.

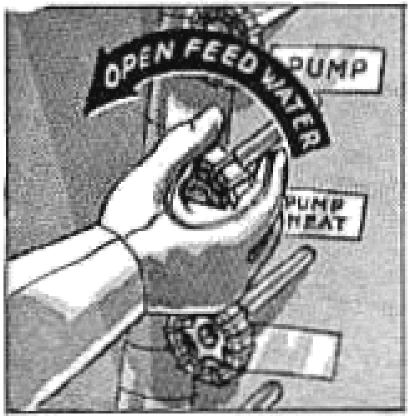
WHAT TO DO IN CASE OF PRIMING

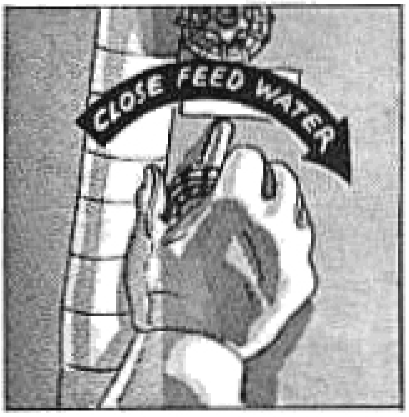
1. Shut off the supply of feed water by closing the feed-water supply valve until the boiler water drops to the proper level.

2. Use the manual blowdown, if it is necessary and if conditions permit. The real purpose of the manual blowdown is to get rid of dirt and sludge which cause foaming. The use of the blowdown to lower the level of good clean water is wasteful and should be avoided.

3. Resume the water supply when the proper level is reached, but at a lower rate than before to avoid again getting too much water into the boiler. Refer to Unit P-5, How to Pump the Boiler.







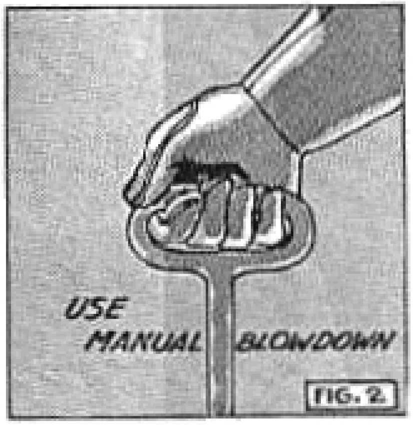


FIG. 2

HOW TO USE THE MANUAL BLOWDOWN

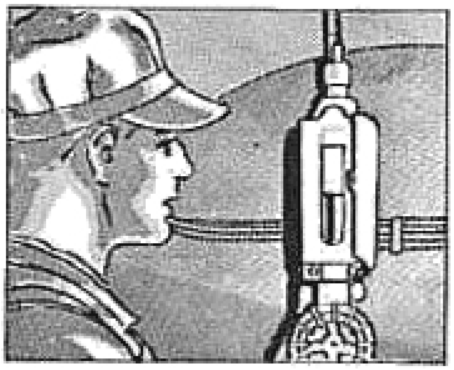
1. Note the location of the manual-blowdown operating handle (Fig. 2) in front of the seat box.

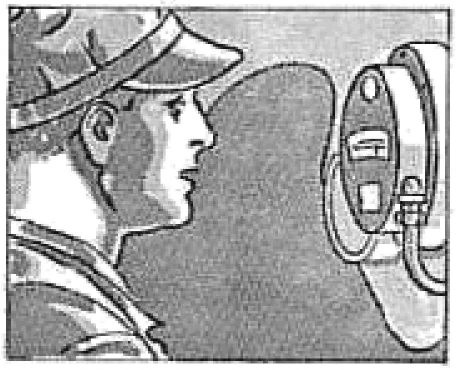
2. See whether or not the locomotive is equipped with an automatic blowdown. An automatic blowdown reduces the need for using the manual blowdown. Refer to Unit I-10, Boiler Blowdown Systems.

3. Study the local instructions for blowing down the locomotive.

4. Use the manual blowdown often in accordance with local instructions and after the locomotive has stood for some time. When starting, open the manual blowdown to get the sediment out before it circulates, if conditions permit.

CAUTION: Always make certain that no one is close enough to be injured when the blowdown valve is opened.





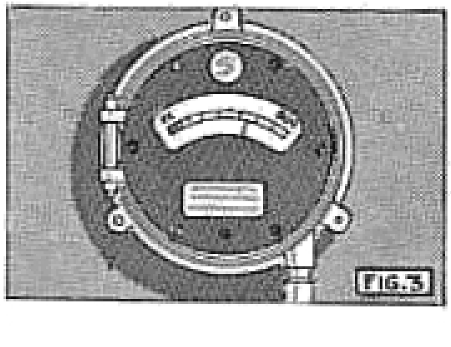


FIG.3

5. Watch the pyrometer for indications of foaming or priming. Refer to Unit P-11, How to Interpret Pyrometer Readings.

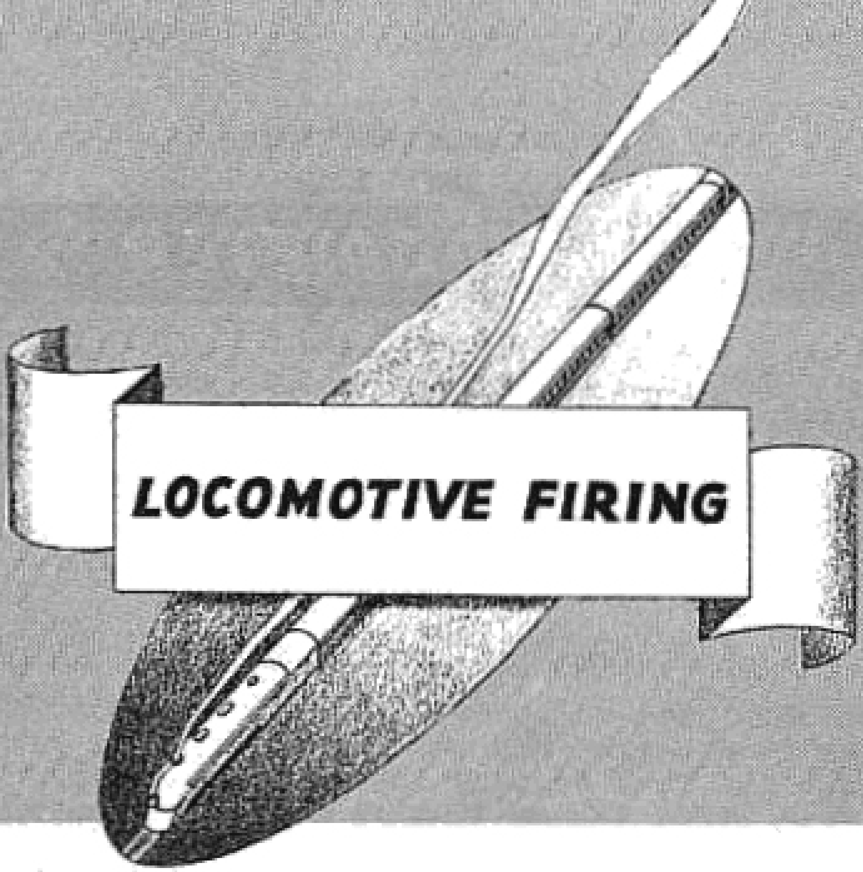
HOW TO TEST THE AUTOMATIC CONTINUOUS BLOWDOWN

1. Test the type operated by the water pump by opening the pump throttle sufficiently to register at least fifty pounds discharge pressure on the water-pump gage. Observe the bottom of the separator drain pipe. If a discharge of water comes from the drain pipe, the blowdown is in working order. See Unit I-10 for a description of the automatic blowdown.

2. Check the type operated by the throttle valve when the main throttle valve is open. A discharge of water from the drain pipe from the separator indicates that the blowdown is in working order.

3. Watch the pyrometer gage (Fig. 3) for indications of foaming or priming. Refer to Unit P-11, How to Interpret Pyrometer Readings.

4. Check the water glasses and the gage cocks, if the locomotive is working water, to see whether the condition is caused by high water or by foaming.



LOCOMOTIVE FIRING

THE PYROMETER

UNIT I-11
Pages 126-128

UNIT P-11
Pages 129-130

UNIVERSITY OF THE STATE OF NEW YORK
STATE EDUCATION DEPARTMENT
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TECHNICAL EDUCATION

THE PYROMETER

OBJECTIVES

1. To describe the pyrometer.
2. To show the close relation between the pyrometer reading and the conditions in the firebox.
3. To point out the importance of superheating.

INTRODUCTORY INFORMATION

The pyrometer is used on locomotives equipped with a superheater. It indicates to the crew whether or not they are getting the increased power and fuel economy that can be obtained from superheated steam. The pyrometer reading is one of the best indications that the fireman has as to the conditions in the firebox and in the boiler.

It is interesting to note that the pyrometer indicates the TEMPERATURE of the superheated steam at the cylinders of the locomotive and is a more sensitive indication of fire and boiler conditions than the boiler PRESSURE gage

The pyrometer (Fig. 1) consists of three units: (1) a thermo-couple unit which reacts to very slight changes in temperature and is attached to the locomotive valve chamber; (2) an electrically operated gage which is located in the cab; and (3) a cable which connects the thermo-couple to the gage.

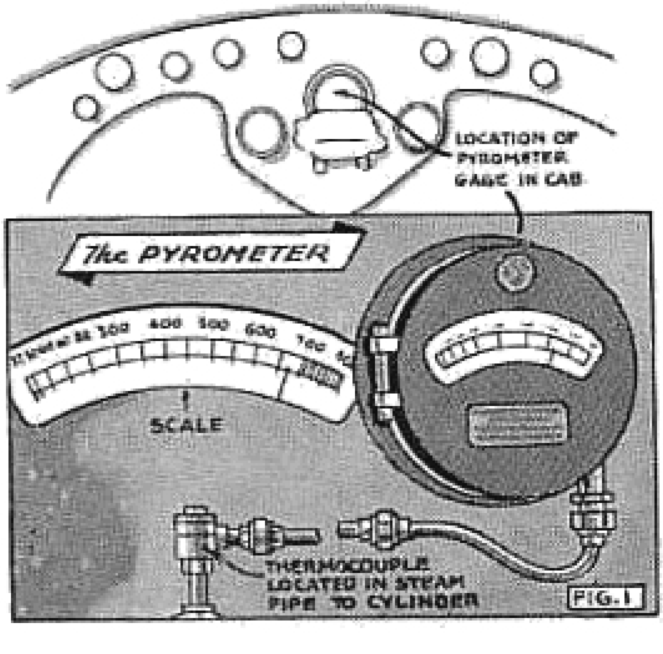

LOCATION OF PYROMETER GAGE IN CAB
The PYROMETER
300
400
500
600
700
800
SCALE
THERMOCOUPLE LOCATED IN STEAM PIPE TO CYLINDER

FIG. 1

The indicating scale on the gage reads from 32° to 800° F. The figures from 32° to 300° are small because they are not so important. The figures from 300° to 800° are important because the effectiveness of the superheater is indicated by the readings within this temperature range.

USE OF THE PYROMETER

The pyrometer is effective only while the locomotive is being worked because the temperature reading of the steam is taken as it enters the valve chamber. The reading should range from 600° to 750° F. A reading lower than this range while the locomotive is being worked, indicates that something is wrong. Careful observation of pyrometer readings under all conditions of locomotive performance will soon familiarize the fireman with the most efficient pyrometer temperature.

A GRADUAL DROP in temperature indicates an improper condition of the fire or impaired draft. A RAPID DROP in temperature or a fluctuating reading, indicates that water is being carried over into the superheater units either because the boiler water is foaming or because the water level is too high. Both foaming and high water will cause water to be carried to the cylinders.

Failure to maintain satisfactory pyrometer readings with good fire conditions in the firebox and good boiler conditions indicates that something is wrong. This condition should be reported.

DESCRIPTION OF THE SUPERHEATER

The superheaters used on American locomotives all work on the same general principle. They add heat to the steam after it has left the boiler. A superheater does not increase the steam pressure in the boiler, but it does increase the steam efficiency.

The essential parts of a superheater are the header and the superheater units (Fig. 2). The header is located in the smokebox and has two compartments. One compartment receives the saturated steam from the steam dome of the boiler and passes it to the superheater units. The other compartment of the header receives the superheated steam from the superheater units and passes it to the cylinders. Most modern superheater locomotives have the throttle installed in the superheated steam compartment of the superheater header instead of in the steam dome which was the usual location in older locomotives.

The superheater units are located within the boiler flues. Each unit consists of four straight tubes joined together with machine-forged return bends so that each unit is complete with one connection into the saturated steam chamber, another connection into the superheated steam chamber of the header, and four straight tubes within the boiler flues in which the saturated steam is heated.

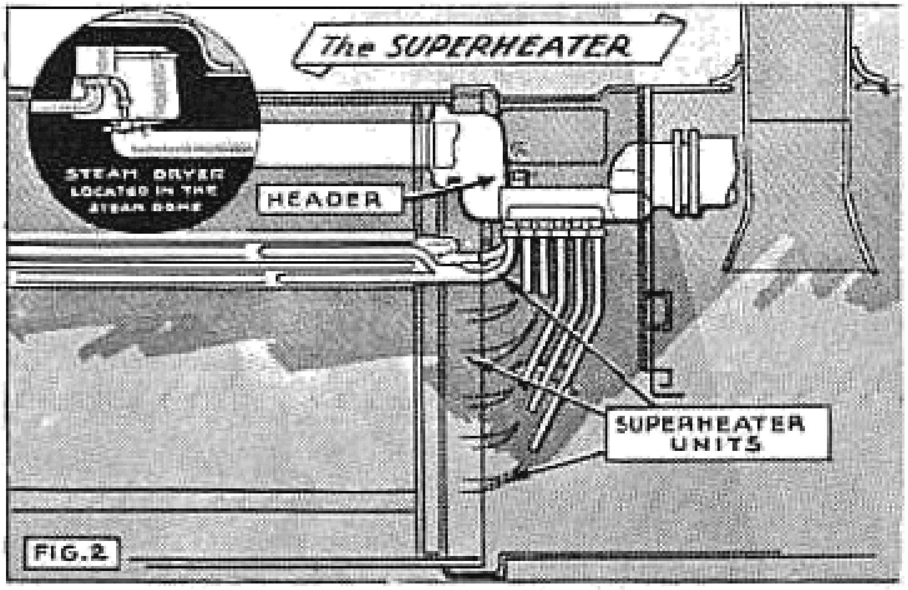


FIG. 2

A superheater increases the

hauling capacity of a locomotive about thirty per cent and reduces both fuel and water consumption about twenty-five per cent.

To be effective, a superheater locomotive must have a hot fire in the firebox. A bright, clean fire maintained at a minimum thickness and kept clean, level, and even in depth is essential. A hot fire is indicated when flames are bright and short. A low firebox temperature is indicated by long, smoky flames. Excessively bright spots indicate a low spot and too much draft at that point. Dark spots and smoky flames indicate poor combustion or not enough draft through that area.

Because the pyrometer indicates how well the superheater is functioning, the pyrometer gage gives a good indication of the kind of fire in the firebox.

SELECTED REFERENCES

Examinations for Firemen and Hostlers	New York Central System
Instructions for the Preparation and Maintenance of Locomotive Fires	New York Central System
Traveling Engineers' Examination Book	Railway Fuel and Traveling Engineers' Association
Locomotive Cyclopedia	Simmons, Boardman Pub. Co.
Instruction Book	The Superheater Co.

HOW TO INTERPRET PYROMETER READINGS

OBJECTIVES

1. To explain the purpose of the pyrometer.
2. To point out when the pyrometer should be read.
3. To explain how to interpret the pyrometer reading.

INTRODUCTORY INFORMATION

The gages found in the cab of a locomotive provide the crew with valuable information about the performance of the locomotive. They eliminate guesswork and uncertainty and provide a sound foundation upon which to judge what is taking place in the firebox and the boiler.

The pyrometer is one of the most important gages on the locomotive. It indicates the temperature of the superheated steam entering the cylinders and reacts very quickly to any changes in steam conditions. Because the pyrometer gives such an accurate indication of the conditions in the locomotive boiler and in the firebox, its readings should be watched closely. Defects in the pyrometer should be reported.

PROCEDURE

WHEN THE PYROMETER READING IS HIGH

1. Make regular inspections of fire and boiler conditions. The pyrometer reading (Fig. 1) will be the highest when the engineman is working the locomotive the hardest because of the large amount of superheated steam passing through the cylinders. Refer to Unit I-11 for an explanation of pyrometer readings.
2. Observe the pyrometer readings frequently under all conditions of locomotive speed and work (Fig. 2) so that you can tell when the locomotive is working at its best efficiency.
3. Compare the pyrometer readings with different conditions in the firebox and with different conditions of the boiler water. A little experience will enable you to interpret pyrometer readings.

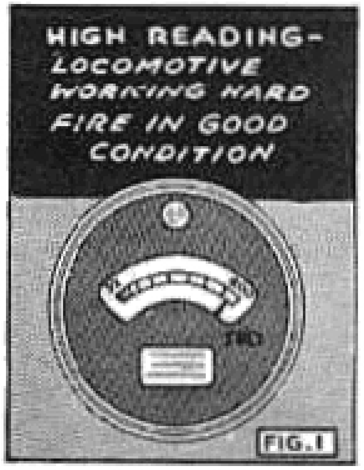

HIGH READING-
LOCOMOTIVE WORKING HARD
FIRE IN GOOD CONDITION

FIG. 1

WHEN THE PYROMETER READING IS LOW

1. Check the water level in the boiler. When the water level in the boiler is too high, there

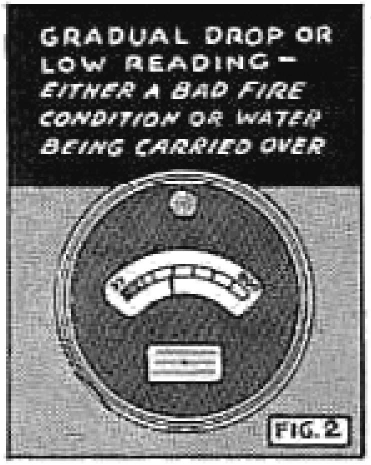
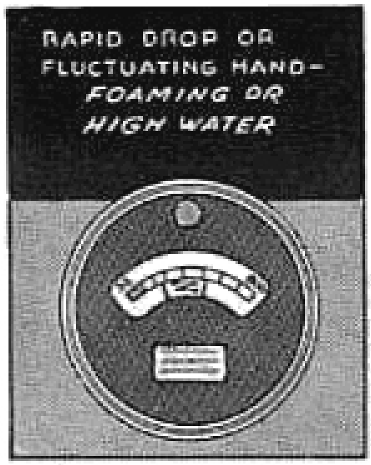

GRADUAL DROP OR LOW READING—
EITHER A BAD FIRE CONDITION OR WATER BEING CARRIED OVER

FIG. 2



will be a carry-over of water with the steam to the superheater. This lowers the efficiency of the locomotive by its effect on the superheated steam. In addition, the lubrication of the cylinders and valves may be affected, resulting in friction and possibly in damaged parts. Refer to Unit P-5, How to Pump the Boiler, for instructions on checking the water level.

2. Reduce the water supply to the boiler if the water level is too high.

3. Notify the engineman so that he can ease off on the throttle and open the cylinder cocks if the water is too high in the boiler.

4. Use the manual blowdown (if conditions permit) in accordance with local instructions. Refer to Unit P-10, How to Use the Manual Blowdown, for instructions.

5. Inspect the fire for a bad fire condition such as holes, banks, or fire creeping off the back grates. If a bad fire condition exists, it will be accompanied by a drop in the boiler-pressure gage reading.

6. Take immediate steps to improve the fire if bad conditions are found. Refer to Unit P-8, How to Correct Bad Fire Conditions, and Unit I-8, What Can Happen to a Fire, for information.

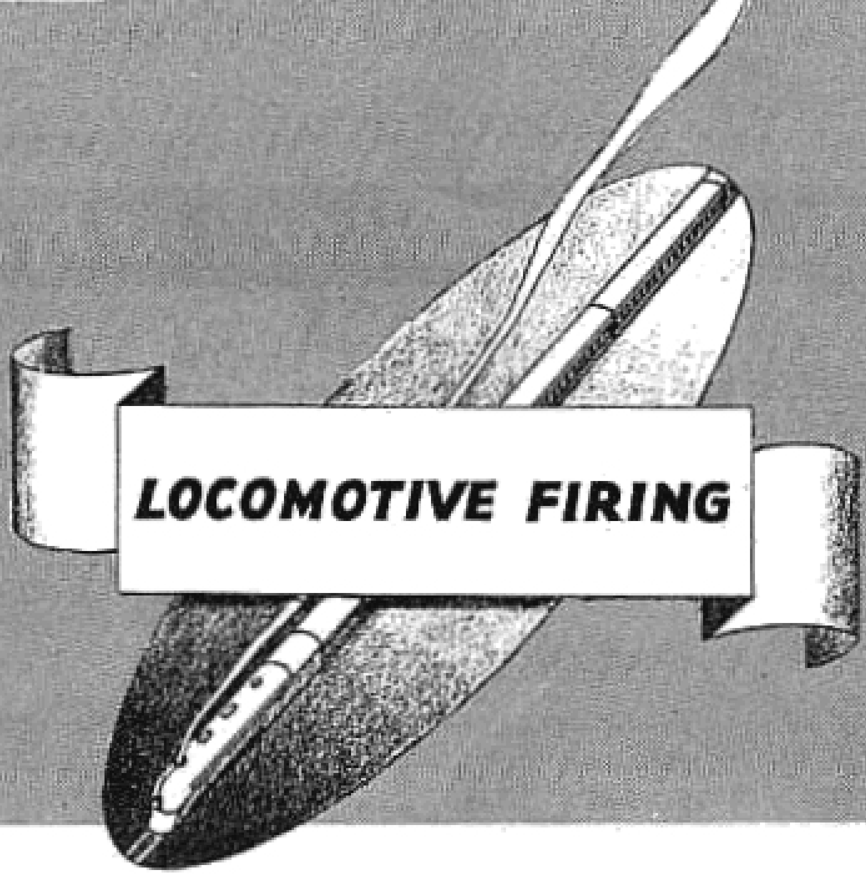
7. Observe the pyrometer when the locomotive is being worked under different conditions so that you will know what the normal reading should be.

WHEN THE PYROMETER READING FLUCTUATES

1. Check the water level in the boiler. When the pyrometer fluctuates, it gives an indication that water is being carried over from the boiler. This can be caused by high water or by foaming.

2. Notify the engineman, correct the water level in the boiler, and use the manual blowdown as explained above.

3. Inspect the fire and correct bad conditions if they are found. Both foaming and high water result in conditions that contribute to a hard steaming locomotive. They have a tendency to increase the draft and thereby disturb the fire bed.



LOCOMOTIVE FIRING

PLUGGED NETTINGS

UNIT I-12
Pages 132-133

UNIT P-12
Pages 134-137

UNIVERSITY OF THE STATE OF NEW YORK
STATE EDUCATION DEPARTMENT
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UNIT I-12

CAUSES OF PLUGGED NETTINGS

OBJECTIVES

1. To describe the front-end netting.
2. To explain the function of the front-end netting.
3. To tell why front-end nettings plug.
4. To explain the effect of a plugged netting on the fire.

INTRODUCTORY INFORMATION

The netting consists of a screen in the front end of the locomotive so arranged that the combustion gases must pass through it to go out of the smoke stack (Fig. 1). The purpose of the netting is to prevent burning cinders or fuel from going out of the stack in pieces so large that they will continue to burn long enough to start a fire along the right of way.

The netting causes no difficulty under normal conditions, but if an excessive amount of cinders or partly burned coal is carried over, the effective netting area cannot handle it. This results in a plugged netting and a steam failure. A piece of netting that has been plugged is shown in Fig. 1).

It has been definitely proved that plugged nettings can be avoided if the fireman understands the causes and then fires the locomotive accordingly. A plugged netting kills the fire by choking off the draft through the firebox. This is a very serious condition for when it occurs the locomotive must either be pulled off the run or the cinders must be cleaned from the netting and the smokebox.

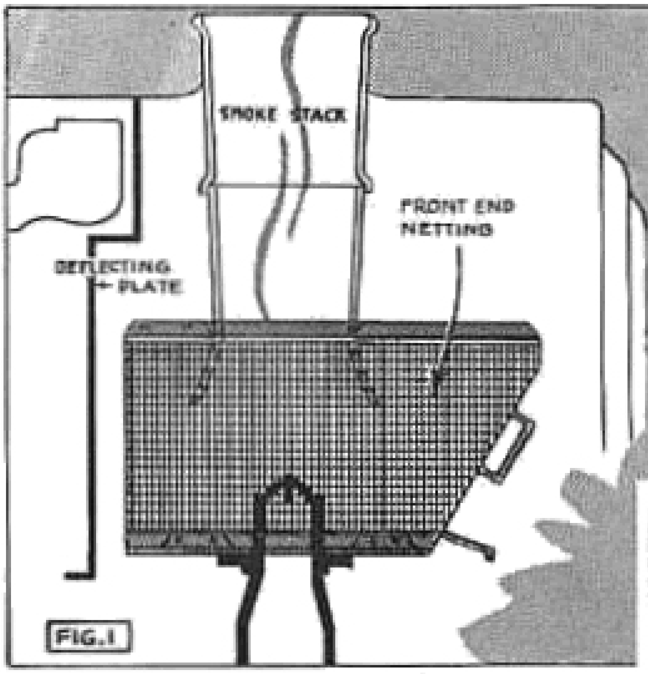
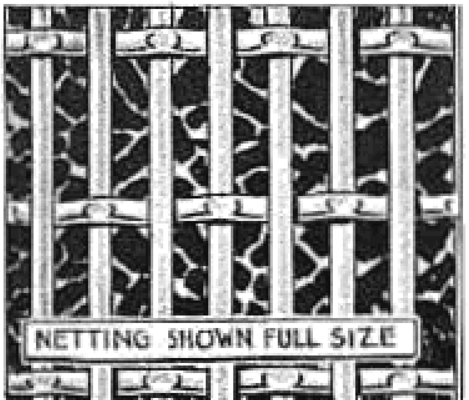


FIG. I

Plugged nettings must be avoided by preventing the development of conditions that will cause an excessive carry-over of material from the firebox.



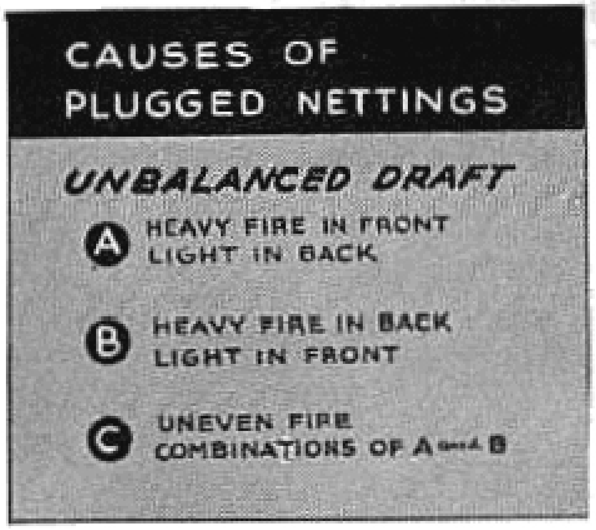
NETTING SHOWN FULL SIZE

CAUSES OF PLUGGED NETTINGS

It has been found that most plugged nettings are a direct result of an UNBALANCED DRAFT through the fire bed. Any fire condition which causes an unbalanced draft through the fire bed increases the carry-over of unburned fuel and cinders over the brick arch and tends to plug the front-end netting. Basically, this is a result of an uneven distribution of coal in the firebox.

When these conditions exist, the normal flow of air is decreased through the heavy portion of the fire. This increases the draft through the lighter portion of the fire. If the stoker is used to feed coal to the light portion of the fire while the locomotive is working hard, the increased draft creates a larger carry-over of cinders and partly burned coal to the smokebox than the effective netting area can handle. This results in a plugged netting and a steam failure. Refer to Unit P-12 for instructions for preventing plugged nettings.

Crew cooperation plays an important part in the prevention of plugged front-end nettings. A wide-open throttle or capacity operation when the fire is not in the proper condition will increase the "carry-over" and plug the netting.



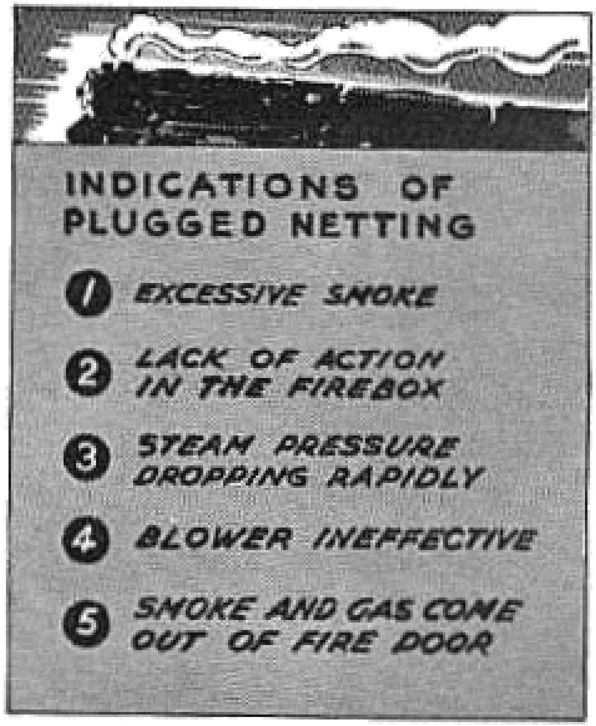
CAUSES OF PLUGGED NETTINGS

UNBALANCED DRAFT

Ⓐ HEAVY FIRE IN FRONT LIGHT IN BACK

Ⓑ HEAVY FIRE IN BACK LIGHT IN FRONT

Ⓒ UNEVEN FIRE COMBINATIONS OF A and B



INDICATIONS OF PLUGGED NETTING

① EXCESSIVE SMOKE

② LACK OF ACTION IN THE FIREBOX

③ STEAM PRESSURE DROPPING RAPIDLY

④ BLOWER INEFFECTIVE

⑤ SMOKE AND GAS COME OUT OF FIRE DOOR

SELECTED REFERENCES

Examinations for Firemen and Hostlers	New York Central System
Instructions for the Preparation and Maintenance of Locomotive Fires	New York Central System
Traveling Engineers' Examination Book	Railway Fuel and Traveling Engineers' Association
Locomotive Cyclopedia	Simmons, Boardman Pub. Co.

HOW TO PREVENT PLUGGED NETTINGS

OBJECTIVES

1. To explain what is meant by a "plugged netting."
2. To tell how to prevent the netting from becoming plugged.
3. To explain how to correct conditions that cause plugged nettings.
4. To explain how crew cooperation may help to prevent a netting from becoming plugged.

INTRODUCTORY INFORMATION

A plugged netting causes a steam failure and makes it necessary to take a locomotive out of service or to clean the netting and the smokebox on the road.

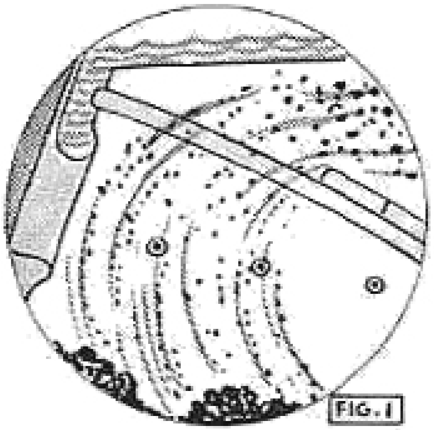


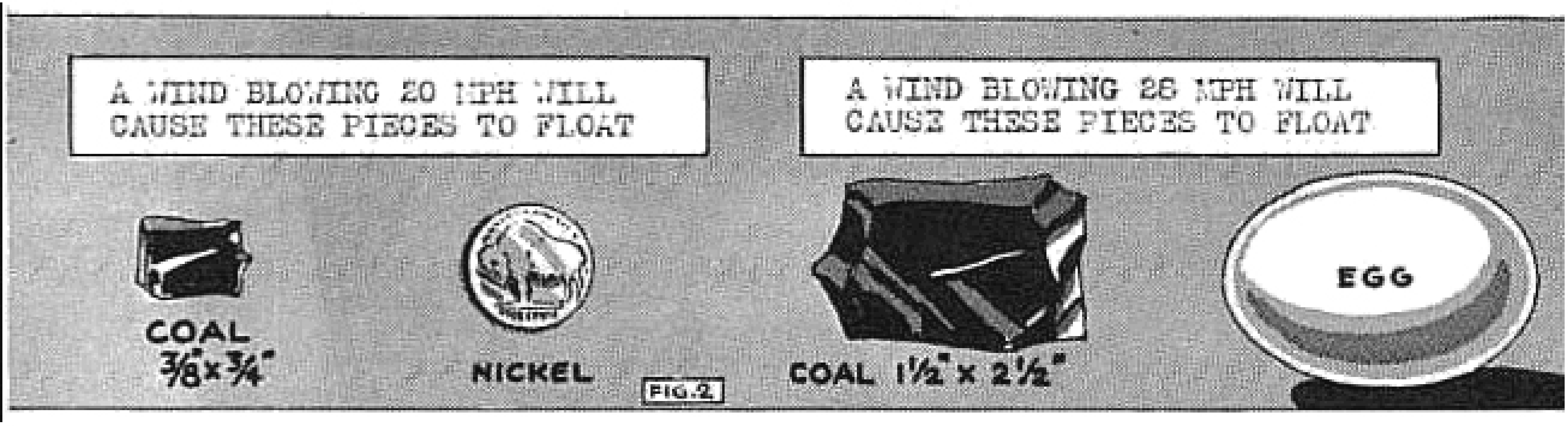
FIG. 1

Nettings too often become plugged as a result of poor firing practices which allow the draft to become unbalanced. An unbalanced draft carries unburned coal over the brick arch (Fig. 1) and deposits it on the netting. Fig. 2 shows the size of the pieces that will be carried over at higher than normal speeds and illustrates why it is important to maintain an even fire. Refer to Unit I-12 for a description of the netting.

The draft through the fire bed is evenly distributed when the fire is in good condition on the grates and, as a result, the speed of the air through the fire bed is relatively low as illustrated in Fig. 3.

EQUIPMENT REQUIRED

Standard Firing Equipment


A WIND BLOWING 20 MPH WILL CAUSE THESE PIECES TO FLOAT
A WIND BLOWING 28 MPH WILL CAUSE THESE PIECES TO FLOAT
COAL 3/8x3/4"
NICKEL
COAL 1½" x 2½"
EGG
FIG. 2

PROCEDURE

HOW TO PREVENT PLUGGED NETTINGS

1. Inspect the fire frequently to determine whether or not conditions are present which may cause an unbalanced draft through the fire bed. The most effective method of preventing a plugged netting is to make certain that the fire is in good condition by making frequent inspections. FREQUENT INSPECTIONS will detect bad fire conditions early so that they can be corrected before they cause serious delays. Refer to Unit P-2, How to Inspect the Fire.

2. Estimate the depth of the fire by checking the distance from the top of the fire bed to the smoke-consumer holes which are approximately twenty inches from the grates.

   NOTE: The correct depth of the fire and ash should be ten inches or less.

3. Watch for conditions that cause an unbalanced draft.

   a. Check the fire for light spots or holes (Fig. 4) which cause an unbalanced draft through the fire bed. This condition may result in a carry-over of cinders or unburned fuel and is one of the main causes of a plugged netting.

   b. Check for a heavy fire under the arch and for drifts or banks in other parts of the firebox. These cause an unbalanced draft condition because the draft is restricted through the deep portions of the fire and is intensified through the light portions.

HOW TO CORRECT AN UNBALANCED DRAFT CAUSED BY HOLES OR LIGHT SPOTS

1. Notify the engineman of the fire condition if it is serious.

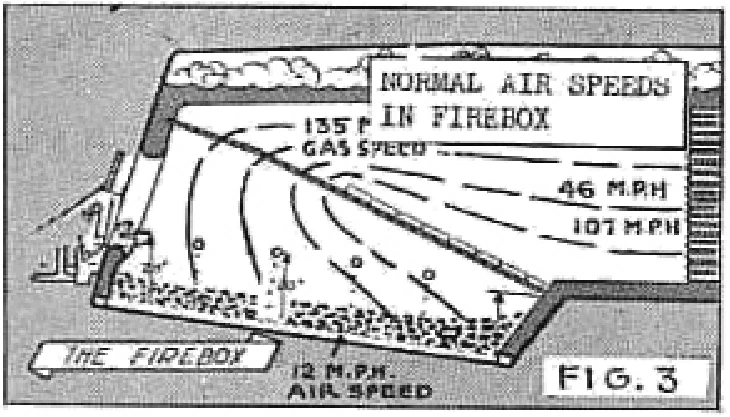


FIG. 3

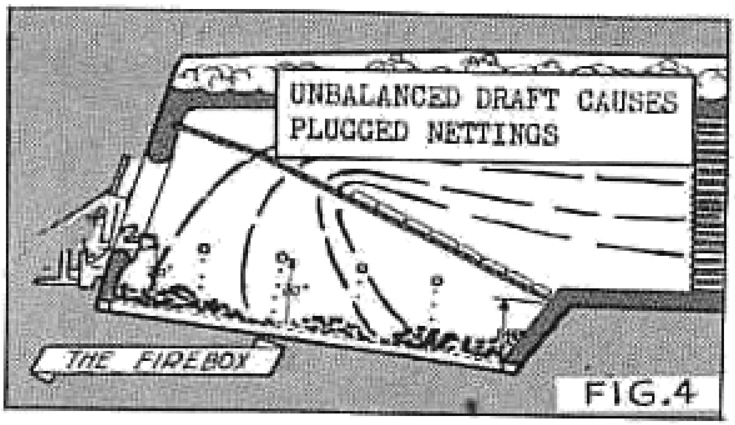


FIG. 4

He may assist by easing off on the throttle, or by closing the throttle if necessary, until the condition can be remedied.

NOTE: If coal is supplied to the light spot while the locomotive is working hard, the heavy draft may cause a high carry-over and a plugged netting results.

2. Fill in the holes or light spots by hand firing with the scoop. It is not practicable to fill in holes by feeding coal with the stoker as the draft is so strong that it will carry the coal over the arch (Fig. 4).

3. Readjust the stoker jets to distribute the coal evenly over the fire bed.

4. Inspect the fire frequently. Frequent inspections will enable the fireman to discover bad conditions in the firebox before they become serious.

HOW TO CORRECT AN UNBALANCED DRAFT RESULTING FROM A LIGHT SPOT ON THE BACK GRATES

1. Inspect the fire, giving special attention to the back end of the firebox directly under the distributing table.

   It is difficult to see this part of the firebox and a bad condition at this point can be easily overlooked. If the fire is extra bright below the distributing table it may be assumed that there is a hole or light spot in that area.

2. Correct the condition by the procedure given in the preceding section for other light spots.

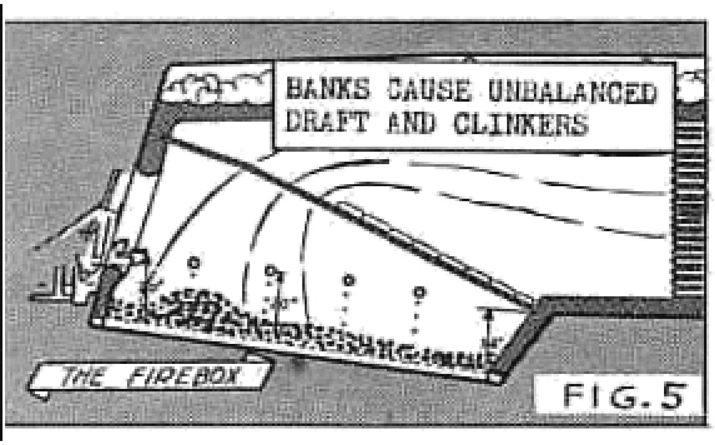
HOW TO CORRECT AN UNBALANCED DRAFT CAUSED BY BANKS

1. Determine the cause of the bank (Fig. 5).

   NOTE: In addition to causing an unbalanced draft, banks may cause clinkers to form.

2. Apply one or more of the following remedies, as required, to correct the condition. In some cases it may be necessary to use all three methods.

   a. Move the grates under the heavy portion of the fire to increase the draft through the banked area.

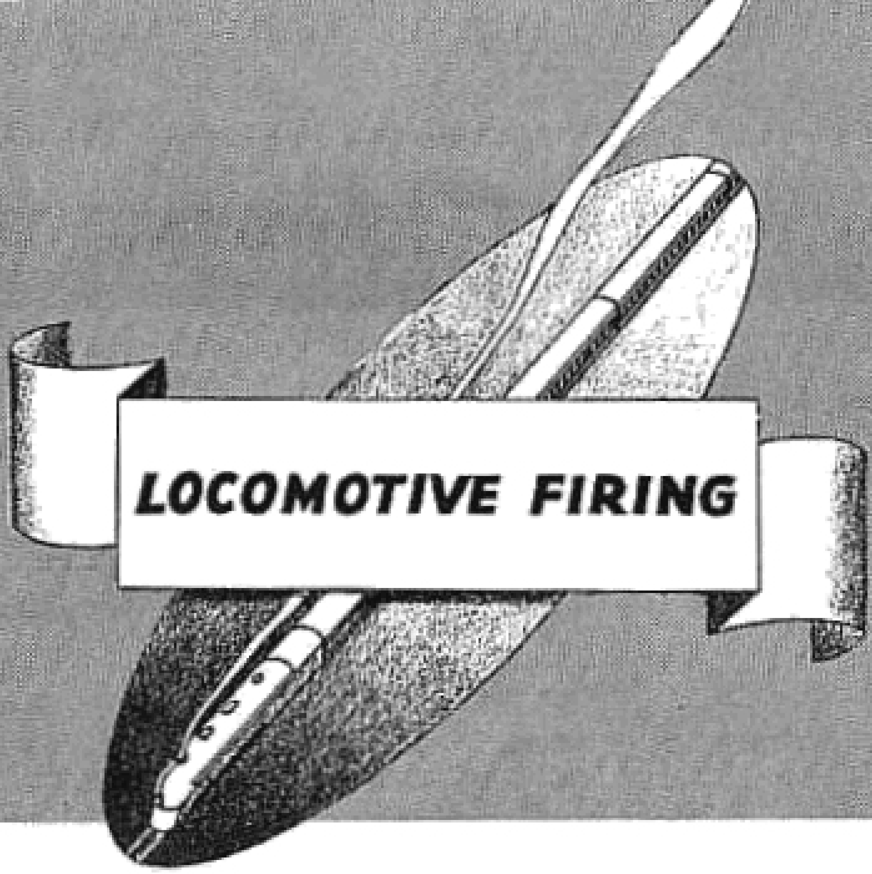

BANKS CAUSE UNBALANCED DRAFT AND CLINKERS
THE FIREBOX
FIG. 5

   b. Level off the bank with the rake, being careful not to disturb the fire bed as this might start a clinker. Refer to Unit I-6 for causes of clinker formation.

   c. Hand fire the light portions of the fire, if necessary, to equalize the draft.

3. Readjust the stoker jets to distribute the coal evenly over the fire bed.

4. Inspect the fire frequently to make certain that the cause of the bank has been eliminated.



SMOKE CONTROL
AND
DRAFT CONTROL

UNIT I-13
Pages 140-143

UNIT P-13
Pages 144-146

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THE SMOKE CONSUMER and the BLOWER

OBJECTIVES

1. To describe the blower.
2. To tell what the blower does.
3. To describe the smoke consumer.
4. To explain how the smoke consumer eliminates smoke.

INTRODUCTORY INFORMATION

The blower and smoke consumer are used to assist in maintaining the fire and in preventing excess smoke. Good judgment in the use of both of these devices is essential.

The blower and the smoke consumer are described in two separate sections of this unit.

THE BLOWER

DESCRIPTION OF THE BLOWER

The blower is a device used to create a draft through the fire bed when the locomotive is not working. It consists of three units: (1) a blower-control valve attached to the turret or to the superheated steam pipe to the cylinders (Fig. 1); (2) a ring fitting, or a nozzle fitting in the smokebox (Fig. 2); and (3) a pipe which connects the blower valve to the blower fitting.

Two blowers are usually provided on a locomotive, and when this is the case one blower valve is placed on the left side of the cab and one on the right side. The blower on the fireman's side discharges steam through a ring blower and the one on the engineman's side discharges steam through a nozzle or a second ring blower. The blower-discharge fittings are attached to the exhaust-nozzle base in the smokebox at the base of the smoke stack (Fig. 2).

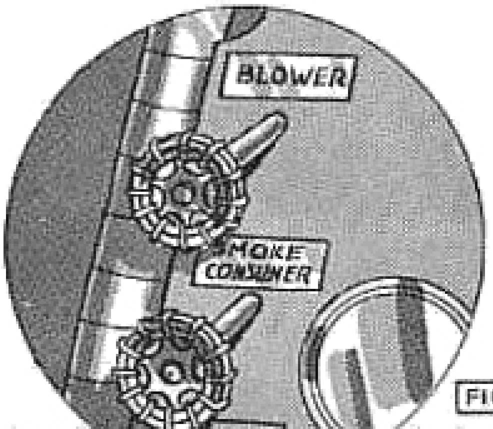


FIG. 1

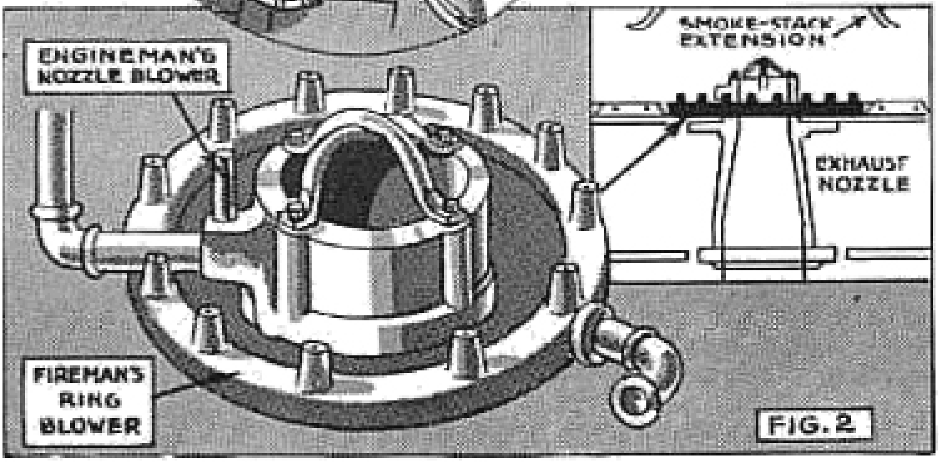


FIG. 2

When the blower is turned on, live steam is discharged out through the smoke stack, thus creating a draft through the fire bed in the same way that the exhaust steam does when the locomotive is working and discharging exhaust steam through the exhaust nozzle (Fig. 2).

USES OF THE BLOWER

The blower has three functions:

1. To create a draft when building up or maintaining the fire before starting the run, and when long stops are made at the stations or on sidings.
2. To keep gases and smoke from coming out into the cab when adding coal and when working on the fire.
3. To control smoke. If the fire starts to die down when the engine is idle it may smoke unless sufficient draft is created with the blower to keep it burning. The blower may be used on a passenger train to lift smoke off the train if the locomotive smokes when the throttle is eased off.

ALWAYS OBSERVE THESE RULES

1. Never use the blower STRONGER than is absolutely necessary
2. Shut off the blower as soon as it has accomplished its purpose. The blower uses live steam and is a heavy drain on the boiler.
3. Use the blower with care if the fire is low or if there are holes in the fire. A draft of cool air may damage flues and staybolts.

WHEN TO USE THE BLOWER

1. Use the blower when starting the fire.
2. Turn on the blower before opening the fire door when hand firing an idle engine to avoid gas and smoke in the cab.
3. Use the blower, if necessary, to assist in avoiding black smoke around stations, terminals, or yards, while maintaining the fire.
4. Use the blower if the fire gets low after a long wait. It is better to keep the fire up than to let it burn down too much and then have to build it up.

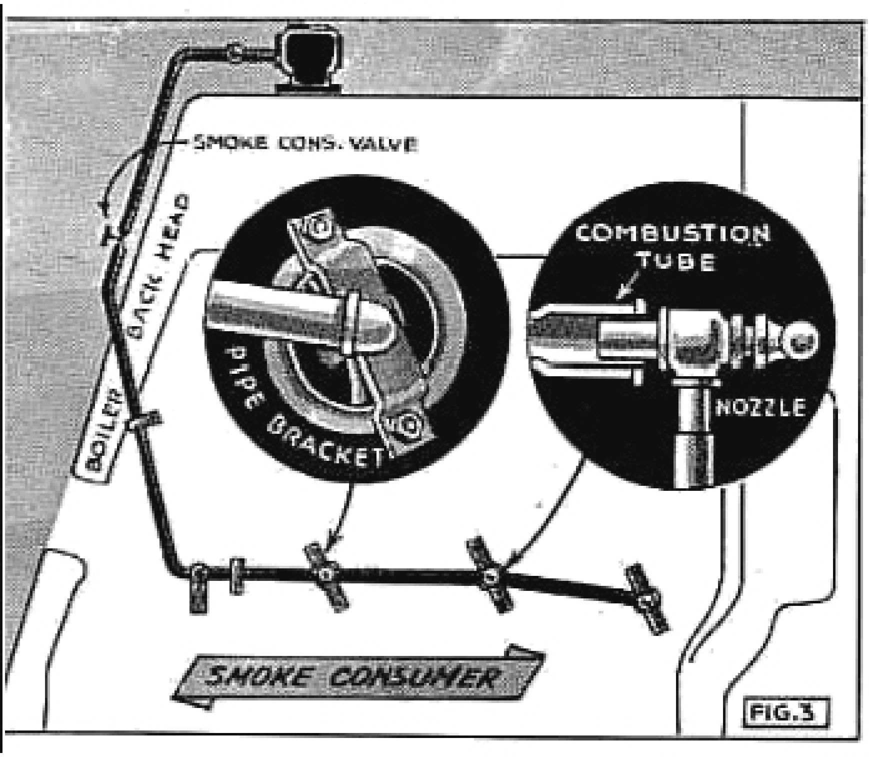


FIG.3

THE SMOKE CONSUMER

DESCRIPTION OF THE SMOKE CONSUMER

The smoke consumer (Fig. 3) consists of a row of nozzles along each of the two sides of the firebox (Fig. 4). These nozzles are attached to conductor tubes along the sides of the firebox about twenty inches above the grates. The nozzles on one side are so arranged that they are not opposite those on the other side. The smoke consumer is turned on and regulated by a valve on the boiler head in the cab.

The nozzles (Fig. 3) are designed so that air is drawn into the firebox with the steam that is discharged from the nozzles when the smoke consumer is turned on. The smoke consumer mixes the steam and air with gases present in the firebox and thus promotes more complete combustion of the gases and also decreases smoke. The staggered arrangement of the nozzles creates cross eddies in the firebox and makes the smoke consumer more effective.

WHEN TO USE THE SMOKE CONSUMER

Apply the smoke consumer whenever the fire is being inspected. This clears up the gases rapidly so that conditions in the firebox can be seen.

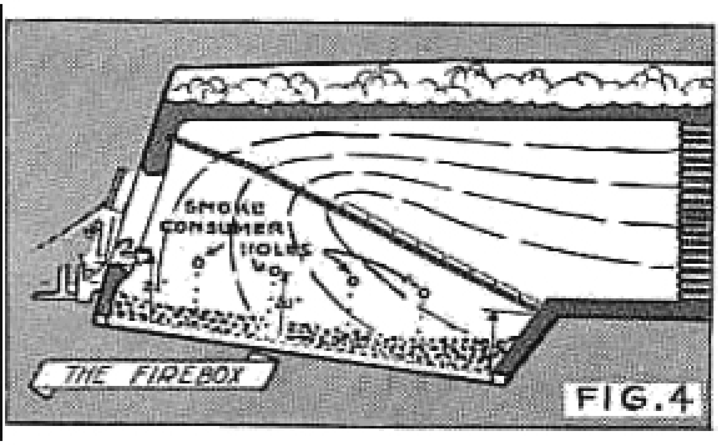


FIG.4

Apply the smoke consumer and the blower at all times when building up or maintaining fires in yards and around stations and terminals. This should be done before supplying coal to the firebox to avoid causing black smoke and to reduce the unburned gases expelled from the fresh coal.

The smoke-consumer valve should be opened before breaking up the bank when the fire is being prepared for train departure, and the blower should be turned on until the smoke clears.

Care should be taken to eliminate smoke in any smoke-restricted territory. Use the smoke consumer, if necessary, to avoid excessive smoke.

SELECTED REFERENCES

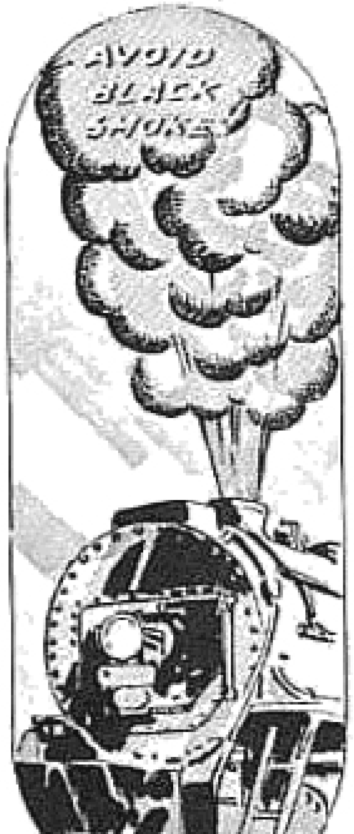
Examinations for Firemen and Hostlers	New York Central System
Instructions for the Preparation and Maintenance of Locomotive Fires	New York Central System

HOW TO PREVENT EXCESS SMOKE

OBJECTIVES

1. To point out the causes of excess smoke.
2. To explain how cooperation between the engineman and the fireman can prevent excess smoke.
3. To explain how to correct fire conditions which cause excess smoke.
4. To explain how to use the blower to eliminate smoke.

INTRODUCTORY INFORMATION



It is assumed that the reader is familiar with the preceding units in this manual and has a good understanding of how to fire a locomotive. This unit emphasizes those things that cause a locomotive to smoke and tells what to do to prevent excess smoke.

Excess smoke can be avoided if the fire is in good condition, if coal is supplied to the firebox in the proper amount, and if the coal is evenly distributed over the fire bed.

Black smoke is an indication of a waste of coal and is the result of overcrowding the fire, or, in other words, feeding coal to the firebox in such a quantity that a sufficient supply of air cannot be obtained to burn the fuel.

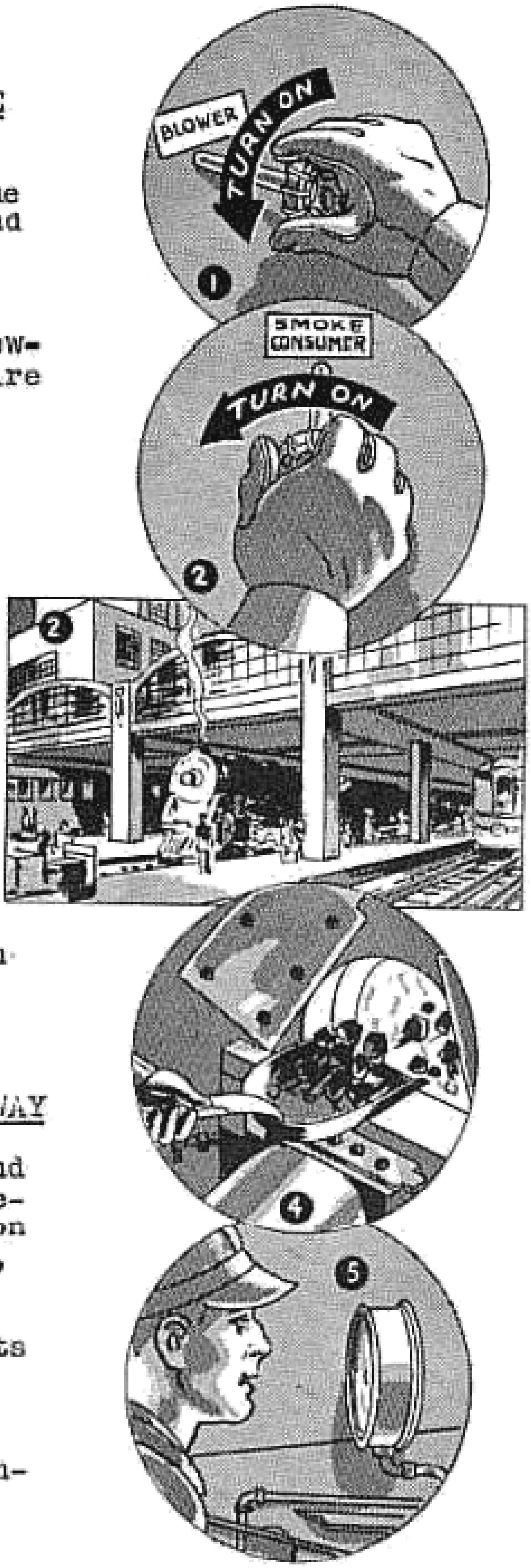
The proper use of the blower when the engine is idle and at other times when the throttle is closed, will assist in eliminating smoke. The blower should never be used stronger than is absolutely necessary and should be shut off as soon as it accomplishes its purpose because it uses live steam directly from the boiler and burns out the fire.

The smoke consumer should be used when coal is being added to the fire when the locomotive is idle and at other times when the throttle is closed.

EQUIPMENT REQUIRED

Standard Firing Equipment

PROCEDURE



PREVENTING SMOKE WHEN PREPARING THE FIRE BEFORE STARTING OUT

1. Turn on the blower before adding coal to the fire. The blower should be used lightly and then turned off as soon as the smoke is cleared up.

   NOTE: When the locomotive is idle, the blower should be turned on before the fire door is opened so that the smoke and gases will not come out into the cab.

2. Apply the smoke consumer before supplying coal to the firebox when building up or maintaining fires around stations, terminals, and in yards. Refer to Unit I-13 for a description of the smoke consumer and blower.

3. Open the fire door.

4. Add coal around the center bank or in the center of the horseshoe bank by handfiring with the scoop.

5. Check the boiler pressure.

   NOTE: The fire should be in good condition and should have within fifty pounds of maximum steam pressure when the locomotive is turned over to the crew.

PREVENTING SMOKE WHEN THE LOCOMOTIVE IS UNDER WAY

1. Inspect the fire frequently for evenness and to make certain that the proper depth is being maintained. For complete information on how to inspect the fire, refer to Unit P-2, How to Inspect the Fire.

   NOTE: Uneven distribution of coal restricts the draft at the high spots and results in incomplete combustion and excess smoking. Light spots intensify the draft causing a high carry-over of cinders and unburned coal which tends to cause plugged front-end nettings.

2. Watch the grade, size, and condition of the coal in the tender, and regulate the stoker speed and jet pressures accordingly. See Unit I-6 for information on coal and combustion, and Unit P-6 for information on how to fire different kinds of coal.

3. Adjust the stoker to run at an even speed and just fast enough to supply coal according to the steam demand. Refer to Unit P-3, How to Operate the Stoker.

   NOTE: Excess smoke is produced when the rate of firing exceeds the rate of burning.

4. Adjust the stoker jets to the pressure required to get an even distribution of coal over the firebox. Refer to Unit P-4, How to Adjust Stoker Jets.

5. Do not use the stoker to supply coal to the firebox when the locomotive is standing. Maintain the fire by handfiring to keep the boiler pressure up. Apply the smoke consumer as required to prevent smoke and use the blower to assist in preventing smoke and to create sufficient draft to maintain the fire.

   Maintain steam pressure and have the fire in proper condition to start out.

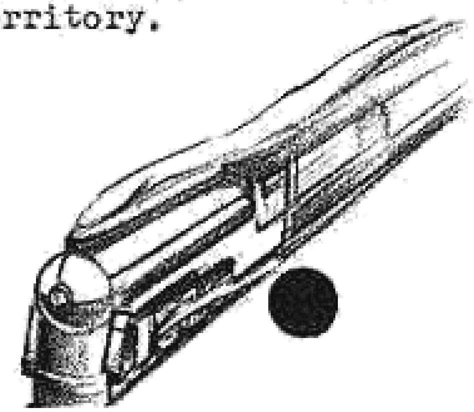
6. Apply the smoke consumer when inspecting the fire and whenever it is required to prevent smoke.

7. Use the blower to assist in preventing smoke and to create sufficient draft to maintain the fire.

8. Avoid overcrowding the fire at all times. A knowledge of the road ahead and the probable demands for more or less steam will enable the fireman to maintain a uniform boiler pressure by controlling his fire according to the demand for steam.

   Close cooperation between the engineman and the fireman is an important factor in the elimination of objectionable smoke.

   NOTE: Take care to eliminate dense smoke in any smoke restricted territory.



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